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Although the journal's main interests have always centred on the history and distribution of Scottish fauna and flora, it is prepared to publish contributions on the many aspects of Scottish natural science embraced by its title, including Zoology, Botany, Geology, History, Geography, Medicine and the allied sciences, Archaeology, and the Environment.

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CHANGES IN DISTRIBUTION AND PERSECUTION OF CARNIVORES IN NORTH SCOTLAND 1912-1970, AS EVIDENCED BY TAXIDERMISTS' RECORDS

By HENRY A. McGHIE
Department of Zoology, The Manchester Museum

Abstract: This paper presents an analysis of the records of Otter *Lutra lutra*, Wild Cat *Felis silvestris*, Fox *Vulpes vulpes*, Pine Marten *Martes martes* and Badger *Meles meles* submitted from north Scotland to an Inverness-based firm of taxidermists, John Macpherson and Sons, during 1912-1970 and contained within the firm's 'stuffing books'. Variations in the numbers submitted are examined in relation to geographic area and land use, in light of known or supposed changes in population sizes and distribution of these species, changes in the numbers of gamekeepers, and changes in habitat. Records of Polecat *Mustela putorius*, Ferret *Mustela putorius furo* and Mink *Mustela vison* are also commented upon. The numbers of carnivores submitted increased until around 1930 and declined thereafter. Changes in numbers submitted were greater in the uplands than elsewhere. Numbers submitted were lower during the periods of the two World Wars, and some species showed temporary increases immediately after the wars. The stuffing books provide evidence of the spread of Wild Cat and Pine Marten in Scotland. Aspects of the taxidermy trade, namely the value of the sale of skins and the numbers of animals submitted in relation to the numbers killed, are discussed

Introduction

A number of studies of historical changes in population sizes of carnivores have been based on analyses of hunting and trapping records, both for sporting purposes and for pest control (Hewson and Kolb, 1973; Chanin and Jefferies, 1978; Hewson, 1984; Hudson, 1992; Tapper, 1992). An underlying assumption of this type of work is that numbers killed are directly related to the population sizes of the target species. There is usually no evidence of this although, importantly, Kolb and Hewson (1980) found that numbers of Foxes killed were directly related to Fox density as determined by scat counts. Taxidermists' records have not previously been used for this purpose, although McGhie (1999) used them to examine changes in status of birds of prey and variations in persecution in north Scotland. An underlying assumption of the present study is that there is a direct relationship between the numbers of animals submitted for preservation and the numbers available, for whatever reason, at any given time. A comparison between the numbers of Wild Cats submitted to Macpherson's in the 1930s and 1940s with

the numbers given by Jenkins (1962) demonstrated that high numbers of Wild Cats were submitted from estates which had killed high numbers of Wild Cats. The reverse was not always true, however, so that some estates, which had killed high numbers of Wild Cats, submitted few cats for preservation. Conversely, no estate submitted larger numbers of Wild Cats for preservation than had been killed on the estate. This provides some circumstantial evidence to support the assumption of a relationship between numbers submitted and numbers obtained. It is appreciated that over such a long time period as 1912-1970 different factors will have been of varying importance at different times. These factors are likely to include the desirability of skins and consequent financial value, fashion for taxidermy and skins, carnivore population sizes, persecution pressure, and persecution methods. However, over periods of shorter duration within this period, the same factors should apply to all areas, and variations in numbers will require explanation; it is these variations which form the substance of this paper.

It is likely that all the species of larger carnivores still resident in Britain were originally resident throughout much of mainland Scotland; many were also found on Skye, the Hebrides and some of the smaller islands. By the early 20th century, the Polecat was practically extinct in Scotland, the Wild Cat and Pine Marten were greatly reduced in numbers and distribution, and the Fox was absent from parts of eastern Scotland (e.g. Ritchie, 1920; Langley and Yalden, 1977). Declines in north Scotland mainly occurred in the 19th century; this period coincided with the development of the sporting estate, mainly for grouse shooting and deer stalking, which became increasingly popular from the early 19th century. Persecution of predators was a fundamental part of game preservation (Langley and Yalden, 1977; Eden, 1979; Orr, 1982; Tapper, 1992). Carnivores were also in demand for their skins (e.g. Ritchie, 1920), which were especially popular in the late 19th and early 20th centuries. Prior to the 1930s, most furs came from wild animals as opposed to farmed animals (North, 2000), although home-produced skins formed only a small part of the British fur trade since most skins were imported from America and the continent (Rosenberg, 1927). Carnivores increased in numbers and range during the 20th century to varying degrees, so have recolonised areas from where they had previously been extirpated. These increases have been linked with declines in persecution which occurred after each of the two World Wars (e.g. Langley and Yalden, 1977; Hudson, 1992; Tapper, 1992).

There is a large body of information available for north Scotland between 1880 and 1904 (see mainly Harvie-Brown, 1881-82; Harvie-Brown and Buckley, 1887, 1888, 1895 and 1904; Millais, 1904-06) There is less contemporary information available for the early 20th century (Ritchie, 1920; Taylor, 1946; Darling, 1947; Jenkins, 1962; Lockie, 1964), when some species are considered to have increased

in range and almost certainly in numbers. Various accounts of the changing status of individual species have been published, largely based on the afore-mentioned material (Langley and Yalden, 1977; Jefferies, 1989; Cresswell, Harris and Jefferies, 1990; Birks and Kitchener, 1999). Published analyses of changes in distribution during the 19th and early 20th centuries have been constrained by the frequently vague nature of locality information, and it is often unclear whether gaps in distribution represent a lack of information rather than a real absence of animals (see Balharry and Daniels, 1999). Information was often anecdotal or even second or third hand. Quantitative information for the 19th century is practically restricted to vermin lists, most of which are of short duration and cover restricted areas (see e.g. Pearsall, 1950). Information on the methods, intensity, and selectivity of persecution is not usually known. The veracity of some vermin lists has also been called into question since some contain unrealistic lists of numbers and species, notably the oft-quoted list for Glengarry, West Ness (Pearsall, 1950; Shorten, 1954; Brown, 1976; Ratcliffe, 1980). Quantitative data between 1940 and 1970 exist for Fox (Hewson and Kolb, 1973; Hewson, 1984) and Pine Marten (Lockie, 1964); information on Wild Cat is largely based on two questionnaire surveys (Taylor, 1946; Jenkins, 1962). The stuffing books cover the period 1912-1970, and therefore cover the period when many carnivores are supposed to have increased in range and in numbers.

Taxidermy flourished in Britain from the middle of the 19th century, and the number of businesses peaked around 1900 (Frost, 1987; Morris, 1993 analysing Herriott, 1968). Few records, however, of taxidermists' day to day work survive (Morris, 1988), and those of Macpherson's are the only ones for Scotland, with the exception of a summarised book of Lewis Dunbar's in the National Museums of Scotland. Inverness was regarded as a centre for taxidermy in the late 19th and early 20th century (Frost, 1987). This was probably a spin-off from the intense local interest in sport shooting and fishing. Sport shooting in the Highlands and the wearing of furs were both characteristic of conspicuous consumption (see e.g. Eden, 1979; North, 2000). The main taxidermy businesses were John Macpherson and Sons (1887-1976), and William Macleay and Sons (c.1850-1970s); a number of other gun and tackle shops, including Hugh Snowie's, Gray's, Watson's and Graham's also offered a taxidermy service. There was also a branch of Peter Spicer and Sons of Leamington Spa between 1904 and 1920, although this seems to have undertaken little taxidermy work (Frost, 1987). Outside Inverness, the nearest large firms were in Perth, Edinburgh and Glasgow (Frost, 1987) Taxidermy declined after the First World War so there were probably fewer firms in operation in Inverness after 1918. Of the main firms listed above, Spicer's closed its taxidermy business in 1920 and Macleay's in 1954, so that Macpherson's was the

only firm in operation after 1954 (Smith, 1988; Inverness Museum and Art Gallery, Manuscript documents).

Macpherson's and Macleay's dominated the taxidermy scene in Inverness, where competition for work was known to be intense (Smith, 1988). Macpherson's was established by James Macpherson in Inverness in 1887 and was taken over by his nephew, John Macpherson from Kingussie, in 1888 The firm moved to larger premises in 1920, when it became known as 'The Sporting Stores'. Macpherson's trade label for 1930 described the firm as 'gun and fishing tackle makers, taxidermists and furriers'. Macleay's was described as 'taxidermists, fishing tackle and radio manufacturers' on a 1919 trade label (Frost, 1987). Several naturalists, including Harvie-Brown and Millais, used Macleay's as a source of records (see Pitman, 1983); Macpherson's does not appear to have collaborated with naturalists. Macpherson's was the larger of the two firms, and employed a resident taxidermist, John Macdonald, from 1910 to 1969 and a visiting taxidermist from 1968 to 1970; there must also have been other taxidermists working with Macdonald, since the stuffing books contain several kinds of handwriting. The firm remained open for business during both World Wars. When Macpherson's closed in 1976, it was found that the taxidermist's workroom was exactly as Macdonald had left it. Material from this room, including the stuffing books, was passed to Inverness Museum and Art Gallery in 1976, and the taxidermist's workroom was recreated in the public displays of the museum.

Methods

Records of Otter, Wild Cat, Fox, Pine Marten, Badger, Polecat/Ferret and Mink submitted from north Scotland were extracted from the stuffing books on a Watsonian vice-county basis. The study area was the area currently covered by Highland Biological Recording Group, and consisted of the Outer Hebrides (vc110), Skye (vc104), Caithness (vc109), West and East Sutherland (vc108 and vc107), West and East Ross (vc105 and vc106), and West and East Ness (vc97 and vc96). Also included in this area were small sections of Main Argyll (vc98) with West Ness, and part of Elgin (vc95) with East Ness. All references to West and East Ness refer to these vice-counties together with these small extra adjacent sections. This area was naturally served by Inverness as the main town, and since very little taxidermy work was undertaken away from the Highland capital the bulk of work from these vice-counties would have been likely to make its way there. Orkney and Shetland were excluded, since they had their own taxidermy firms in the earlier part of the 20th century. Records of Wild Cat, Pine Marten, Polecat/Ferret and Mink from outside north Scotland were also extracted, since these species are supposed to have undergone significant changes in range during

the period under study (Jenkins, 1962; Lockie, 1964; Cuthbert, 1973, Langley and Yalden, 1977; Birks and Kitchener, 1999). Methods were essentially the same as those used by McGhie (1999) for the analysis of records of birds of prey contained within the same stuffing books.

The stuffing books contain the details of every animal submitted for work, whether or not any work was actually carried out. Each record consists of the species and number of individuals brought or sent in, the date of submission, the name and postal address of the submitter, and directions for preparation. Lists at the back of each book represent skins which were sent out to subcontractors for tanning and making into furs ('dressing') and plucking (the removal of long guard hairs in Otters; Rosenberg, 1927); these lists were cross-checked for extra records. Animals were either preserved for the people who submitted them, or were sold to Macpherson's, in which case they were entered as 'stock' in the lists. The majority of records of 'stock' skins were associated with the addresses of the people who sold them to Macpherson's. A small proportion of records of 'stock' skins had no associated addresses, but these probably came from the area under study and have been included in analyses. Many entries were annotated as to damage to the skin, which usually consisted of damage to the head, neck, tail or legs, or holes or shot wounds to the skin. These kinds of damage would be consistent with animals having died as a result of shooting or trapping. The majority of animals were submitted by estate owners or workers, which further suggests that animals died as a result of persecution.

Taxidermists' identifications were taken at face value, since most species were unlikely to have been confused with any other species; exceptions to this were Wild Cat with Domestic Cat *Felis catus*, and Polecat with Ferret. Records referring to 'Marten Cat' and 'Marten' were taken to refer to Pine Marten. 'Wildcat' and 'Wild Cat' were differentiated from 'Tame Cat' or 'Domestic Cat' in the stuffing books. Identifications of 'Wild Cat' were taken to refer to animals of 'wild cat type' (see Balharry and Daniels, 1999); these are likely to have been animals which showed what are considered to be 'classic' Wild Cat features, including a short bushy tail, tabby pelage, large size and black paws. Entries by one taxidermist differentiated between 'Cat' and 'Tame Cat'; 'Cat' was taken to refer to 'wild cat type' animals in this case. Work on Wild Cats is plagued with problems in defining the 'Wild Cat', the separation of putative Wild Cats from their hybrids with Domestic Cats, and the difference between a 'Wild Cat' and a feral Domestic Cat (see French, Corbett and Easterbee, 1988; Daniels, Balharry, Hirst, Kitchener and Aspinall, 1998; Balharry and Daniels, 1999). Animals included in the stuffing books as Wild Cats may well have included hybrids. Jenkins (1962) found that a series of animals which were classified as 'wildcats' by estate owners and estate

workers were also identified as such by naturalists, so that most estates' ability to identify animals as such was probably as good as anyone's at the time. Records of Polecat and Ferret are discussed below.

There are eight instances recorded in the stuffing books where the taxidermist was to prepare an inscribed tablet to accompany the mounted animal, detailing when and where the animal was secured. Six of these tablets were to contain the months in which animals were secured; these all fell within the same calendar month as that in which the animal was submitted for preservation. Four of these six tablets were to contain the actual date on which the animal was secured: two were submitted to Macpherson's one day later, one was submitted three days later and one was submitted five days later. Seven tablets referred to the places where animals were obtained; five of these were in the same 10km square of the National Grid as the locality from which the animal was submitted (from the postal address) and two were from the adjacent 10km square. These tablets provide circumstantial evidence that the majority of animals were secured close to the date on which they were submitted, and close to the place from where they were submitted. Deterioration of skins would have been an obvious consideration for submitting skins for preservation quickly; most skins were apparently fresh and not dried.

There are several reasons for supposing that animals would be submitted from close to the place where they were obtained. Firstly, unpreserved skins were unlikely to have been traded widely since they had a financial value attached to them. Secondly, very few animals were submitted from areas well outside their known range in the early 20th century: there were no Foxes, Badgers or Pine Martens submitted from the Outer Hebrides, and no Wild Cats or Pine Martens were submitted from Skye. One Wild Cat was submitted from the Outer Hebrides (representing 0.1% of Wild Cat records) and one Badger was submitted from Skye (representing 0.6% of records), localities where these species were not thought to occur (ranges taken from Corbet and Harris, 1991). Also, deterioration would have been a consideration in the early 20th century, as already mentioned, restricting the movement of unpreserved skins. On these grounds, it was considered that the localities from which the majority of animals were submitted were likely to have been close to the areas from which they originated, and so a geographical analysis was therefore permissible.

The localities from which animals were submitted were traced using a searchable database of place-names on the Ordnance Survey web-site (www.ordsvy.gov.uk). Most previous studies of this type have used the estate as the unit of data analysis (e.g. Jenkins, 1962; Hudson, 1992; Tapper, 1992). This was not possible in the present study, since it was not always possible to determine

from which estate the animals had come, and in any case many animals had come from villages and towns rather than from estates. Analyses were based on the 10km squares of the National Grid to allow these data to be included, and to permit comparisons between vice-counties and areas of differing land use which were of unequal size.

Each 10km square was classified as being typified by upland, lowland or mixed land management practices in the early part of the 20th century. The 'upland land use' class was defined as land managed primarily as grouse moor and/or deer forest with little or no agricultural land (other than sheepwalk). Squares which were classified as being of 'lowland land use' were defined as those consisting of land managed solely as agricultural land with no unenclosed grouse moor or deer forest. Squares containing a combination of the afore-mentioned two classes were classified as being of 'mixed land use'. Squares classified as lowland, mixed and upland constituted 3.5%, 56.0% and 40.5% respectively of all 10km squares in the area under study. Areas of lowland land use were restricted to the low-lying firth-lands of East Ross and East Ness; areas of mixed land use extended up straths and glens and around the coast, whilst the remainder consisted of land under predominantly upland land use. Grouse moors were mainly found east of the Great Glen, in East Sutherland and Caithness, and on selected dry moorlands in East Ross and West Sutherland (Dunrobin Office, 1905; Brown, 1976). Deer forests were widespread in West Sutherland, Ross and Ness (Dunrobin Office, 1905; Orr, 1982). Forestry plantations were most widespread in the mixed land use class, but still common in the lowland land use class (Forestry Commission, 1952). Ten kilometre squares which lay in more than one vice-county were allocated to the vice county which occupied the greatest proportion of the land area in calculations involving the proportions of squares, to avoid double counting, and in order to make comparisons on a unit area basis. No attempt was made to correct the areas of partial squares (squares which were partially occupied by water bodies), but the variable proportion which these constituted of different vice-counties was not thought to constitute a significant error. Similarly, no attempt was made to discount squares which did not contain human habitations, and from which animals could not therefore have been submitted. This was because human occupancy of each square could not be easily ascertained, and in addition would often have been seasonal; in any case, wholly unoccupied squares represented a small proportion of squares, probably less than 5.0%.

The numbers of carnivores submitted from each estate in Sutherland were studied, since good descriptions of the land use on each estate exist for the early 20th century (Dunrobin Office, 1905). This analysis was possible since there were

few localities which could not be reliably allocated to individual estates and there were few villages, which was not true of all areas (see above).

Statistics follow Fowler and Cohen (1986); tests were performed using Microsoft Excel. Maps were produced using the program 'DMAP', designed by Dr. A.J. Morton.

Results

Numbers of Animals Submitted, Types of Record, and Coverage

Totals of 1425 Otters, 1237 Wild Cats, 1157 Foxes, 198 Pine Martens and 143 Badgers were submitted from north Scotland (Table 1, Figure 1). Most animals were preserved for the person who submitted them. Skins of all species were offered for sale to Macpherson's, although the numbers varied greatly between species; the largest numbers of skins of Otter and Wild Cat, and the highest proportions of skins of Pine Marten (18%) and Otter (13%), were offered for sale. Locality information could be traced for the majority of records, although the origin of skins bought for stock was known less often than where animals were preserved for the submitter, presumably because the skins did not have to be returned. The year of submission was known for all of these with the exception of three Wild Cats from East Ness.

Animals were submitted from 63% of all 10km squares of the National Grid in the area under study, varying between 31% and 84% of 10km squares in each vice-county (Table 2). Animals were submitted from a slightly higher proportion of squares from areas of lowland land use, and from a lower proportion of squares between 1940 and 1970 than between 1912 and 1939 (see below). Coverage was considered to be very good.

The distribution of records of each species offered for sale as stock and those to be preserved for the submitter was very similar, so that both of these types of record were analysed together. The small number of skins which were to be preserved for other firms were not included in distributional analyses, since it was less certain where these skins originated.

Distribution of Records of Carnivores

Otter: Otters were submitted from widespread areas in the west, including the coast; in the east, animals were mainly submitted from areas adjacent to large rivers such as the Oykel, Conon, Ness and Spey (Figure 2a and 2b). Before and after the

Table 1. Different categories of records of animals submitted to Macpherson's from north Scotland

Species	Numbers (%) of animals					
	Preserved for submitter		Offered for sale to Macpherson's for stock		Submitted by other firms for preservation	Total
	Address known	Address unknown	Address known	Address unknown[1]		
Otter	1219 (85.5)	4 (0.3)	122 (8.6)	71 (5.0)	9 (0.6)	1425
Wild Cat	1102 (89.1)	1 (0.1)	25 (2.0)	109 (8.8)	0	1237
Fox	1059 (91.5)	0	33 (2.9)	65 (5.6)	0	1157
Pine Marten	160 (80.8)	0	30 (15.2)	7 (3.5)	1 (0.5)	198
Badger	133 (93.0)	1 (0.7)	4 (2.8)	3 (2.1)	2 (1.4)	143

1. Majority of animals likely to have come from north Scotland

Table 2. Coverage

Vice-county/ land use	No. of 10km squares[1]	10km squares of National Grid from which carnivores were submitted					
		1912-39		1940-70		1912-70	
		No. of squares	% of squares	No. of squares	% of squares	No. of squares	% of squares
Outer Hebrides	77	20	26.0	9	11.7	24	31.2
Skye	48	23	47.9	19	39.6	28	58.3
Caithness	25	17	68.0	13	52.0	18	72.0
W Sutherland	42	24	57.1	18	42.9	26	61.9
W Ross	44	34	77.3	31	70.5	37	84.1
W Ness	61	31	50.8	26	42.6	35	57.4
E Sutherland	24	19	79.2	11	45.8	19	79.2
E Ross	36	27	75.0	19	52.8	28	77.8
E Ness	70	51	72.9	41	58.6	53	75.7
Total	**427**	**246**	**57.6**	**187**	**43.8**	**268**	**62.8**
lowland	15	10	66.7	8	53.3	11	73.3
mixed	239	132	55.2	106	44.4	147	61.5
upland	173	104	60.1	73	42.2	110	63.6
Total	**427**	**246**	**57.6**	**187**	**43.8**	**268**	**62.8**

1. Number of 10km squares which lay wholly or mainly within each vice-county

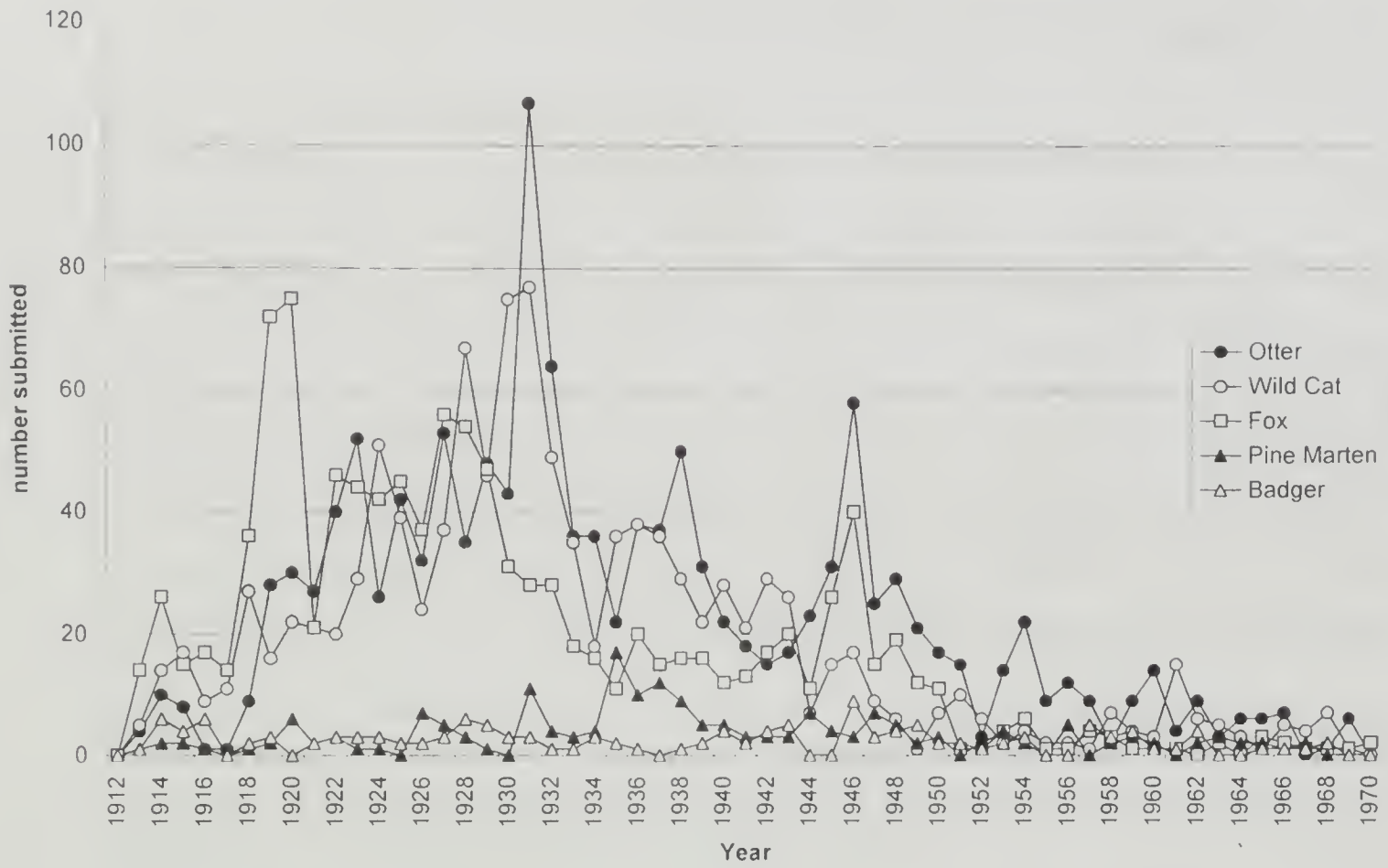

Figure 1

Numbers of Carnivores submitted to Macpherson's from north Scotland

Second World War, Otters were submitted from all vice-counties, with the largest numbers coming from Skye and West Ross (Tables 3 and 5). Relatively low numbers were submitted from the Outer Hebrides during 1912-1970, and from areas of upland land use during 1940-1970 (Table 6). The proportion of Otters which came from each vice county between 1912-39 and 1940-70 was very similar, except for a slight increase in the proportion coming from the Outer Hebrides and a decrease in the proportion from West Sutherland (Table 3).

Wild Cat: Wild Cats were only submitted from West and East Ross and Ness between 1912 and 1919, apart from one record from East Sutherland (Tables 3 and 5; Figure 3a and 3b). East Ness records were from both west and east of the Great Glen at this time. Wild Cats were first submitted from West Sutherland in 1924 and from Caithness in 1930. Wild Cats were first submitted from Speyside in 1929, where they were first recorded in the 1920s (Marshall in Jenkins, 1962). The proportion of Wild Cats which came from Caithness, West and East Sutherland between 1940 and 1970 was more than double the values found for each of these vice-counties between 1912 and 1939. This suggests that there were large changes in the relative distribution of Wild Cats between vice-counties during 1912-1970, with increases in these three vice-counties relative to other vice-counties. The proportions of Wild Cats submitted from vice-counties outside north Scotland in each decade increased significantly between 1912 and 1970 (r_s=1.00, n=6, $P<0.01$)(Table 7). A very small number of records came from areas where Wild Cats were unlikely to occur. Those from Stirling were submitted from Stirling Castle, where the Wild Cat formed part of the regimental insignia of the Argyll and Sutherland Highlanders. Specimens submitted from Greenock, Arran and Islay were almost certainly either large feral domestic cats, or had been obtained from elsewhere. The last accepted Wild Cat recorded from Renfrewshire was in 1895 (Young, 1895; Gibson and Anderson. 1972), and there have never been any genuine Wild Cats on the Clyde islands (Gibson, 1976 and 1985) nor, indeed, on any of the Scottish islands (Alston, 1880; Corbet and Harris, 1991). Wild Cats were submitted from a high proportion of 10km squares from East Ness, particularly east of the Great Glen, and a low proportion of West Ness and Sutherland squares during 1912-1939 (Table 5). The mean number of Wild Cats submitted per positive square was highest in East and West Ross and East Ness at this time; variation was not significant between 1940 and 1970, although Wild Cats were still submitted from a higher proportion of East Ness squares. Wild Cats were submitted from a high proportion of 10km squares of mixed land use during 1912-1939 and a low proportion of upland 10km squares during both 1912-39 and 1940-70 (Table 6). The number of Wild Cats submitted per positive square did not vary significantly between areas of differing land use during 1912-39 or 1940-70.

Figures 2 to 6

Numbers of Carnivores submitted to Macpherson's per 10km square

Otter 1912-39

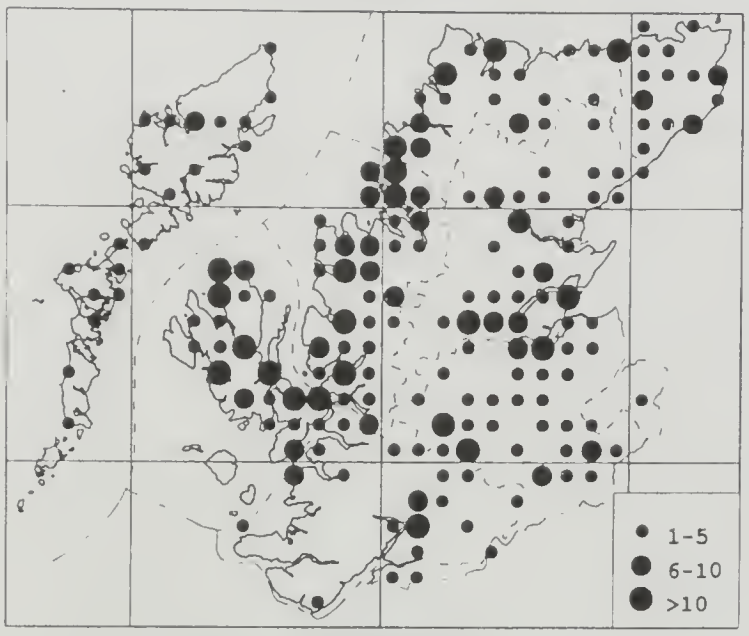

Figure 2a

Otter 1940-70

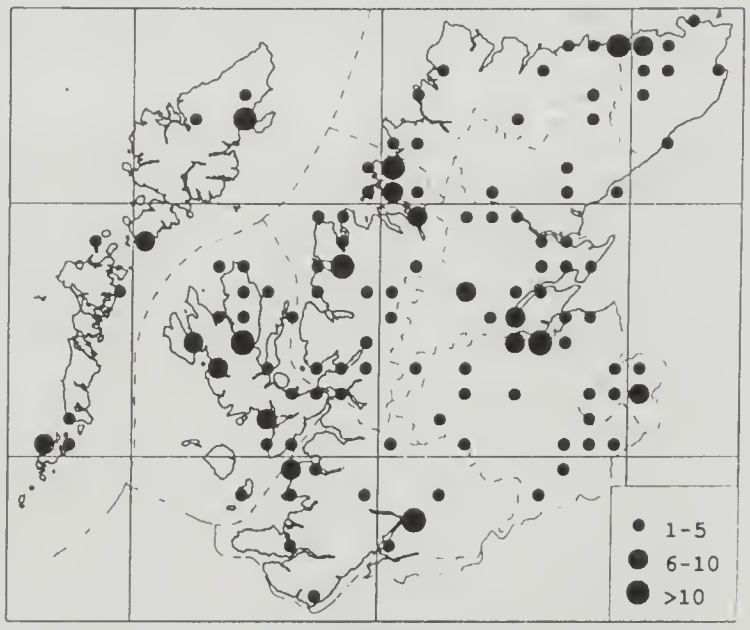

Figure 2b

Wild Cat 1912-39

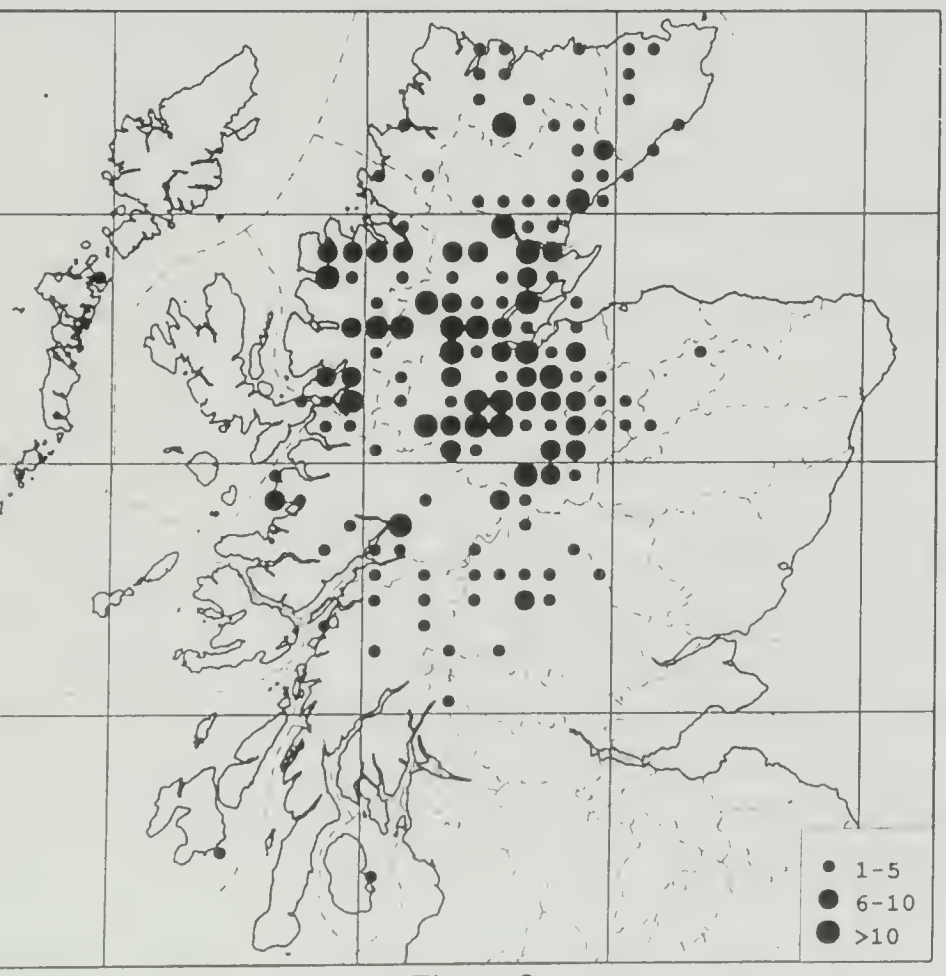

Figure 3a

Wild Cat 1940-70

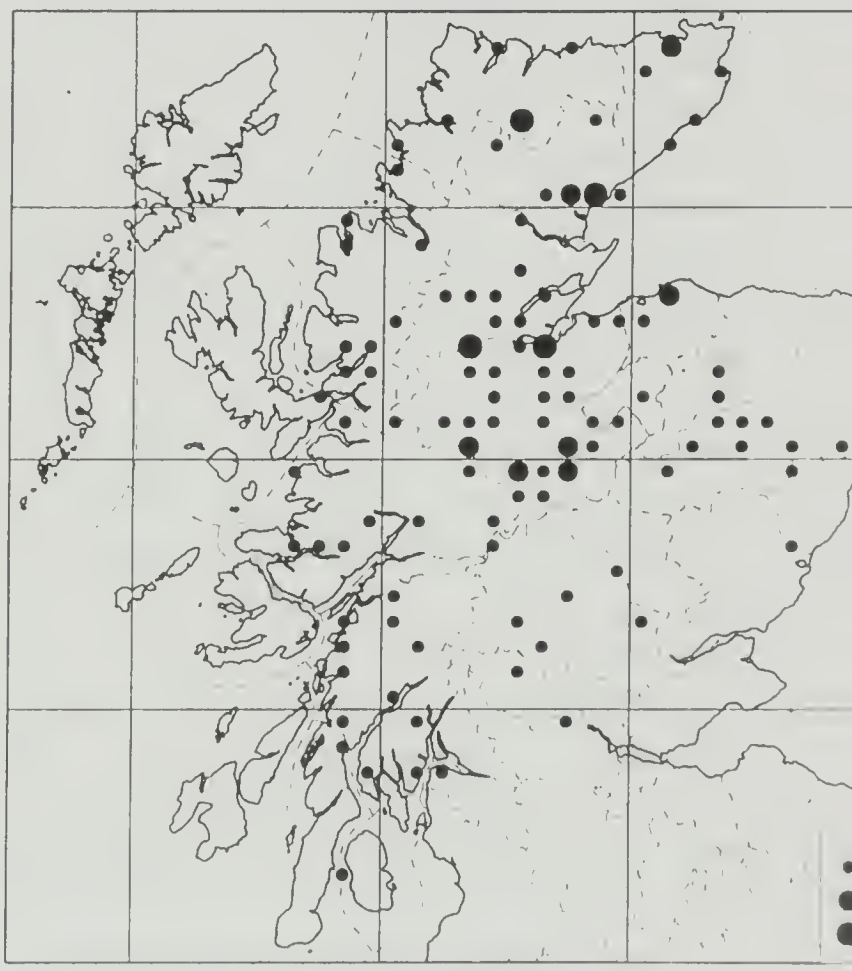

Figure 3b

Fox 1912-39

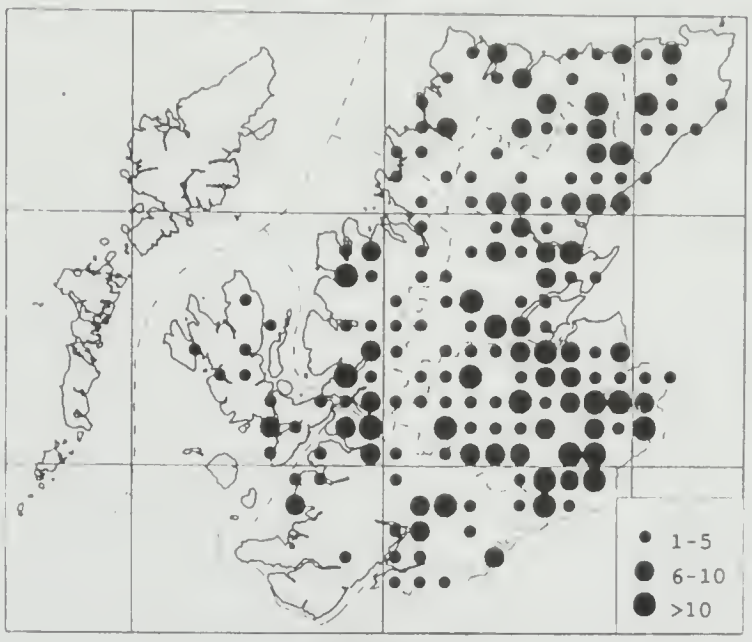

Figure 4a

Fox 1940-70

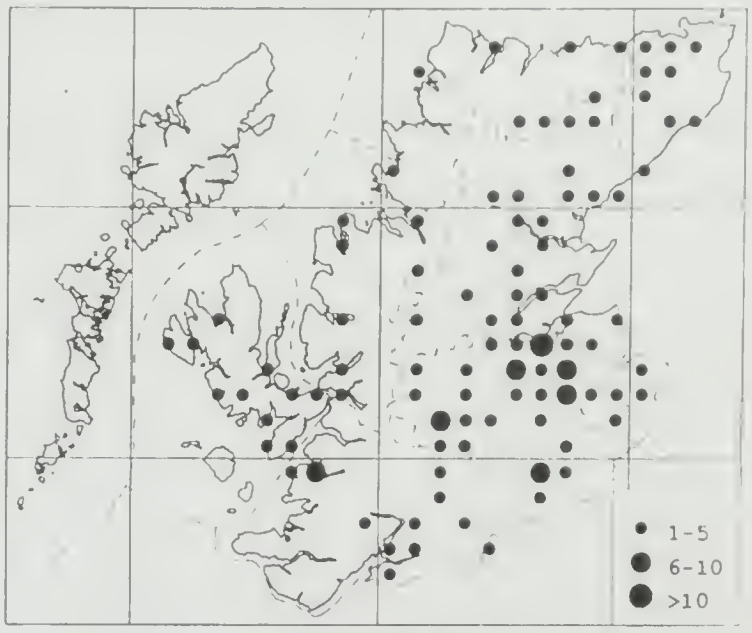

Figure 4b

Pine Marten 1912-39

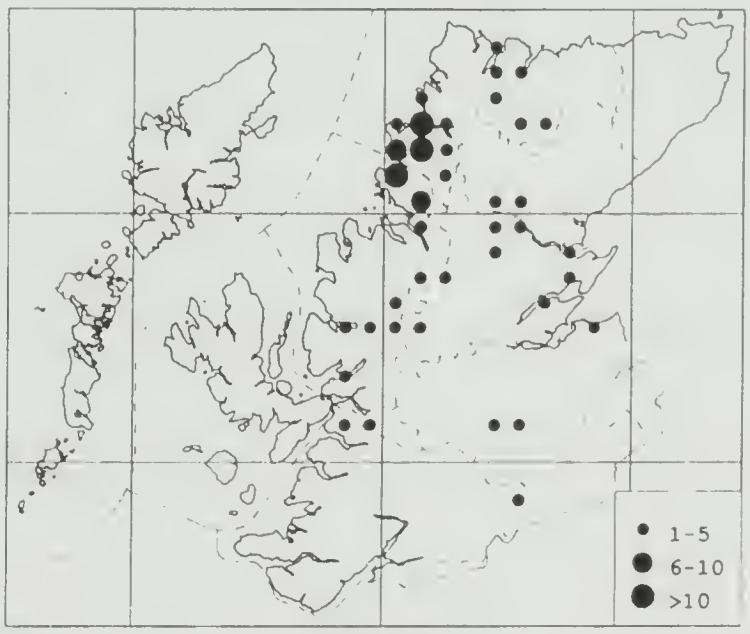

Figure 5a

Pine Marten 1940-70

Figure 5b

Badger 1912-39

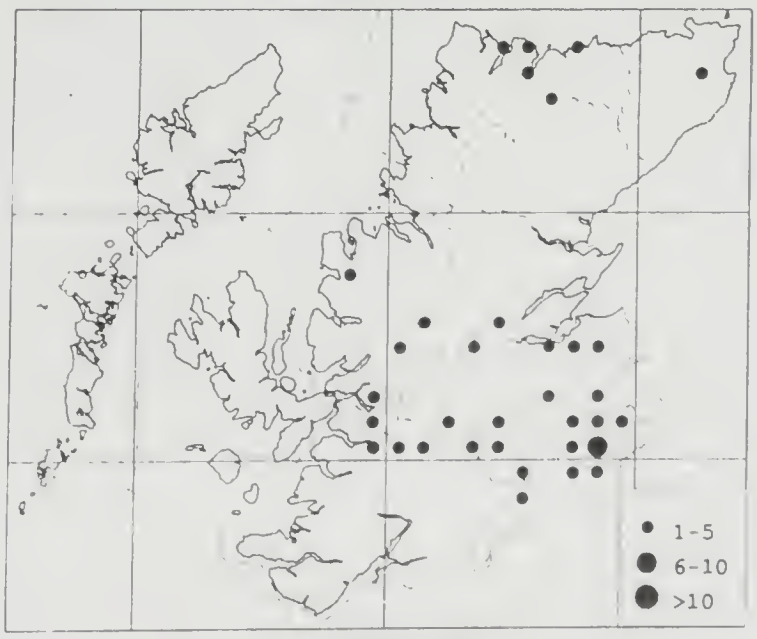

Figure 6a

Badger 1940-70

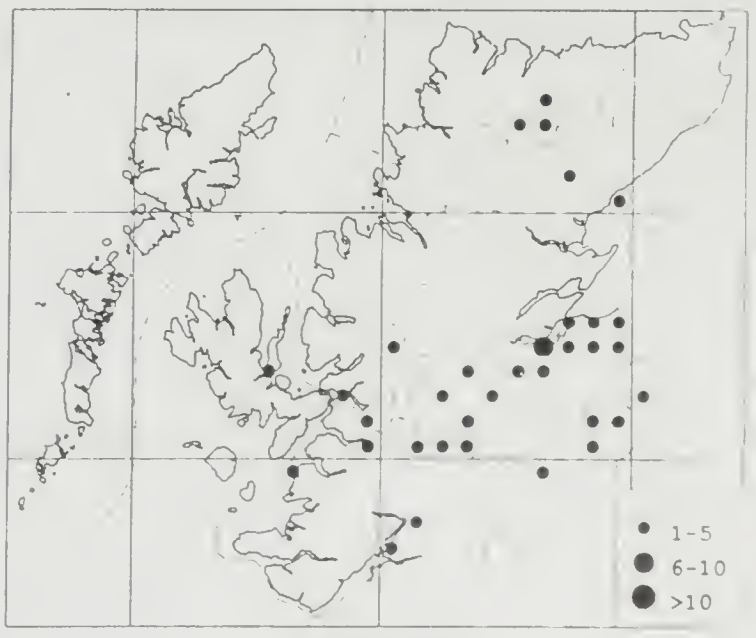

Figure 6b

Table 3. Numbers of carnivores submitted from each vice-county

Species	Vice-county	Numbers of carnivores submitted						
		1912-19	1920-29	1930-39	1940-49	1950-59	1960-70	Total
Otter	O. Hebs.	3	17	34	38	16	1	109
	Skye	9	77	95	31	18	13	243
	Caithness	4	19	42	28	7	3	103
	W Suth	1	34	63	12	8	0	118
	W Ross	12	103	91	62	31	12	311
	W Ness	5	23	39	29	7	6	109
	E Suth	2	17	21	9	4	1	54
	E Ross	7	45	29	24	8	9	122
	E Ness	18	50	50	30	13	11	172
	Total	**61**	**385**	**464**	**263**	**112**	**56**	**1341**
Wild Cat	O. Hebs.	0	0	1	0	0	0	1
	Caithness	0	0	12	11	10	0	33
	W Suth	0	6	23	23	1	1	54
	W Ross	31	68	71	15	3	4	192
	W Ness	9	12	45	18	6	1	91
	E Suth	1	19	27	23	5	14	89
	E Ross	18	80	125	8	4	2	237
	E Ness	40	171	111	61	16	28	430[1]
	Total	**99**	**356**	**415**	**159**	**45**	**50**	**1127**
Fox	Skye	0	23	5	14	2	0	44
	Caithness	1	18	19	11	4	0	53
	W Suth	10	54	15	8	1	0	88
	W Ross	43	46	14	14	1	4	122
	W Ness	21	40	28	25	7	1	122
	E Suth	16	62	28	18	3	1	128
	E Ross	23	51	14	13	1	1	103
	E Ness	80	173	76	82	14	7	432
	Total	**194**	**467**	**199**	**185**	**33**	**14**	**1092**
Pine Marten	Caithness	0	0	0	1	0	0	1
	W Suth	3	10	45	17	1	2	78
	W Ross	1	17	16	12	8	6	60
	W Ness	0	1	1	0	1	2	5
	E Suth	3	0	4	5	2	1	15
	E Ross	2	1	5	3	4	0	15
	E Ness	0	0	4	4	5	3	16
	Total	**9**	**29**	**75**	**42**	**21**	**14**	190
Badger	Skye	0	0	0	0	1	0	1
	Caithness	2	0	0	0	0	0	2
	W Suth	0	0	5	4	2	0	11
	W Ross	1	5	2	1	1	1	11
	W Ness	2	4	1	8	2	1	18
	E Suth	0	0	0	2	0	0	2
	E Ross	0	2	0	0	0	0	2
	E Ness	17	18	9	21	16	9	90
	Total	**22**	**29**	**17**	**36**	**22**	**11**	137

1. Includes 3 Wild Cats for which the date of submission was not known

Table 4. Numbers of carnivores submitted from areas of differing land use

Species	Land use	Numbers of carnivores submitted						
		1912-19	1920-29	1930-39	1940-49	1950-59	1960-70	Total
Otter	lowland	10	31	22	22	8	8	101
	mixed	32	233	336	188	80	33	902
	upland	19	121	106	53	24	15	338
								1341
Wild Cat	lowland	10	27	16	12	10	5	80
	mixed	47	131	138	58	28	35	440[1]
	upland	42	198	261	89	7	10	607
								1127
Fox	lowland	8	28	10	14	8	4	72
	mixed	105	222	91	109	23	7	558
	upland	81	217	97	62	2	3	462
								1092
Pine Marten	lowland	0	0	2	0	1	1	4
	mixed	7	23	34	25	13	6	108
	upland	2	6	39	17	7	7	78
								190
Badger	lowland	0	1	1	9	3	5	19
	mixed	12	12	9	16	14	2	65
	upland	10	16	7	11	5	4	53
								137

1. Includes 3 Wild Cats for which the date of submission was not known

Fox: Foxes were submitted from all mainland vice-counties and Skye both before and after the Second World War; no Foxes were submitted from the Outer Hebrides, where they were not present in the early 20th century (Table 3; Figure 4a and 4b). Foxes were submitted from a high proportion of squares in East Ness, and a low proportion of Skye squares during 1912-39 (Table 5); Foxes also came from a high proportion of East Ness squares and a low proportion of West Sutherland squares between 1940 and 1970. Foxes were submitted from a low proportion of upland 10km squares during 1940-70. The mean number of Foxes submitted per positive square during 1912-39 and 1940-70 was highest in East Ness (Table 5). There was no significant variation in the mean number of Foxes per positive square from areas of different land use during 1912-39 or 1940-70 (Table 6). There was some variation in the proportion of Foxes which originated from each vice-county when the periods 1912-39 and 1940-70 were compared. The proportion from East Ness, which was already considerable, increased slightly and the proportion from Skye doubled, whereas the proportion from West Sutherland declined most and was less than half of that in 1912-39 (see Table 3).

Pine Marten: Pine Martens were submitted from all mainland vice-counties in north Scotland; no Pine Martens were submitted from Skye or the Outer Hebrides, where they were exterminated in the 19th century (Table 3; Figure 5a and 5b). Most Pine Martens were submitted from West Sutherland and West Ross: between 1912 and 1970, forty Pine Martens were sent in from Assynt alone, 20% of all animals; very low numbers, however, were submitted from West Sutherland after 1948. Pine Martens were submitted from Torridon and Assynt between 1912 and 1919, but also from the Kyle of Sutherland to Loch Shin and Strathoykel. During 1920-29 animals were only sent in from West Ross and West Sutherland. Pine Martens were submitted from much wider areas during 1930-39. Apart from West Sutherland and West Ross, they were submitted from Corriegarth (1931), Dell (1934) and even Nairn (1937) in East Ness, and eight localities in East Ross and Sutherland, including the Kyle of Sutherland and Easter Ross. Animals submitted from Loch Droma (1935) and Lochrosque (1937), both near the western boundary of East Ross, may indicate a spread eastwards from the Braemore and Loch Maree/Torridon areas respectively, where Martens were well-distributed and known to be increasing in the 1920s (Lockie, 1964). Similarly, fair numbers were submitted from the Lochcarron district, immediately south of Torridon, from 1938 to 1956, suggesting a spread from Torridon. One animal submitted from Ardverikie (West Ness) in 1931 was most likely to have been one of the two animals released by Fergusson in 1930 (see Darling, 1947). Animals continued to be submitted from West Sutherland and West Ross, as well as the Kyle of

Sutherland and Easter Ross, after the 1940s, although only in very small numbers. Animals were submitted from six localities in East Ness after 1945, all west of the Great Glen; these were the only records from East Ness, excepting those from Corriegarth, Dell and Nairn (all east of the Great Glen) listed above, suggesting spread into these areas. Other records of interest are from Onich, West Ness (1960) and two together from outside the north Scotland area, from Huntly (Moray, vc93) in 1954. Five Pine Martens were submitted from a saddlery firm, Nicholl Brothers, in Bankfoot (Mid Perth, vc88) during 1956-61, but it is not known if these were obtained locally. The proportion of Pine Martens which came from each vice-county during 1912-39 and 1940-70 showed large variation: the proportions from East Sutherland and West Ness doubled; the proportion from East Ness increased fourfold. Pine Martens were only submitted from Caithness once, in 1944. The proportion from West and East Ross was fairly consistent during both periods; the proportion from West Sutherland more than halved (Table 3). The number of squares from which Pine Martens were submitted during 1940-70 was smaller than during 1912-39 in West Sutherland and East Ross, and greater in other mainland vice-counties. There was no significant variation in the proportion of squares from which Pine Martens were submitted from areas of different land use during 1912-39 or 1940-70 (Table 6).

Badger: Badgers were submitted in small numbers; most came from East Ness, especially along the lines of the Great Glen and Strathspey, but also from West Ross, West Sutherland and West Ness. Very small numbers were submitted from other vice-counties; none from the Outer Hebrides (Table 3; Figure 6a and 6b). The proportions which came from each vice-county during 1912-39 and 1940-70 were generally similar, with two-thirds of Badgers coming from East Ness in each period; numbers from East Ness, West Ness and East Sutherland were actually higher during 1940-70 than in 1912-39, in contrast to other species. There was significant variation between mainland vice-counties in the proportions of 10km squares from which Badgers were submitted during 1912-39 and 1940-70, due to Badgers being submitted from a high proportion of East Ness squares (Table 5). The number of squares from which Badgers were submitted during 1940-70 was smaller than during 1912-39 in West Sutherland, West and East Ross, and greater in other mainland vice-counties. There was no significant variation in the proportion of squares from which Badgers were submitted from areas of different land use during 1912-39 or 1940-70. There was significant variation in the number of animals submitted per positive square, however, with higher numbers coming from lowland squares (Table 6).

Table 5. Numbers of carnivores submitted from different vice-counties in relation to 10km squares of the National Grid

Species	Vice-county	Total no. of squares	No. (%) of 10km squares from which submitted[1]		Mean (& 95% CI) no. submitted per positive square[2,3]	
			1912-39	1940-70	1912-39	1940-70
Otter	O. Hebs.	77	20 (26.0)	9 (11.7)	2.4 (1.8-3.1)	3.4 (1.4-7.2)
	Skye	48	20 (41.7)	16 (33.3)	5.0 (2.9-8.2)	2.8 (1.7-4.4)
	Caithness	25	15 (60.0)	9 (36.0)	3.4 (2.1-5.0)	3.2 (1.6-5.6)
	W Suth	42	18 (42.9)	9 (21.4)	4.2 (2.8-6.1)	1.7 (1.2-2.4)
	W Ross	44	31 (70.5)	22 (50.0)	5.1 (3.7-7.1)	3.0 (1.9-4.6)
	W Ness	61	21 (34.4)	11 (18.0)	2.3 (1.4-3.6)	2.7 (1.4-4.7)
	E Suth	24	10 (41.7)	5 (20.8)	2.1 (1.4-3.2)	1.9 (0.8-3.5)
	E Ross	36	15 (41.7)	13 (36.1)	3.9 (2.2-6.6)	2.6 (1.7-3.9)
	E Ness	70	30 (42.9)	21 (30.0)	2.7 (1.9-3.6)	2.0 (1.3-2.8)
Wild Cat	Caithness	25	6 (24.0)	5 (20.0)	1.8 (0.9-2.9)	3.8 (2.3-6.0)
	W Suth	42	11 (26.2)	5 (11.9)	1.8 (0.9-3.2)	2.2 (0.2-7.4)
	W Ross	44	19 (43.2)	11 (25.0)	5.2 (3.1-8.3)	1.8 (1.2-2.5)
	W Ness	61	16 (26.2)	12 (19.7)	2.5 (1.4-4.2)	1.7 (1.0-2.5)
	E Suth	24	14 (58.3)	6 (25.0)	2.4 (1.4-3.6)	4.1 (1.4-9.9)
	E Ross	36	20 (55.6)	8 (22.2)	6.4 (3.7-10.6)	1.6 (1.1-2.3)
	E Ness	70	40 (57.1)	24 (34.3)	4.6 (3.2-6.5)	3.2 (2.2-4.5)
Fox	Skye	48	10 (20.8)	10 (20.8)	2.3 (1.4-3.6)	1.4 (0.9-1.9)
	Caithness	25	10 (40.0)	9 (36.0)	2.9 (1.6-4.9)	1.5 (1.1-2.0)
	W Suth	42	19 (45.2)	7 (16.7)	3.4 (2.4-4.8)	1.6 (1.0-2.3)
	W Ross	44	22 (50.0)	9 (20.5)	3.5 (2.4-4.9)	1.9 (1.3-2.8)
	W Ness	61	24 (39.3)	13 (21.3)	2.8 (2.0-4.0)	2.5 (1.9-3.2)
	E Suth	24	17 (70.8)	9 (37.5)	4.6 (3.5-6.1)	1.8 (1.3-2.4)
	E Ross	36	21 (58.3)	10 (27.8)	3.4 (2.1-5.1)	1.7 (1.1-2.5)
	E Ness	70	46 (65.7)	30 (42.9)	5.1 (3.8-6.6)	2.7 (2.0-3.5)
Pine Marten	Caithness	25	0	1 (4.0)	-	1.0
	W Suth	42	14 (33.3)	7 (16.7)	3.0 (1.8-4.7)	2.0 (0.7-4.0)
	W Ross	44	10 (22.7)	12 (27.3)	2.5 (1.3-4.2)	1.8 (1.1-2.6)
	W Ness	61	2 (3.3)	3 (4.9)	1.0	1.5 (0.6-3.0)
	E Suth	24	2 (8.3)	5 (20.8)	3.0	1.5 (0.9-2.3)
	E Ross	36	8 (22.2)	4 (11.1)	1.1 (0.9-1.3)	1.6 (0.9-2.7)
	E Ness	70	3 (4.3)	4 (5.7)	1.3 (0.8-2.0)	2.2 (1.1-4.1)
Badger	Skye	48	0	1 (2.1)	-	1.0
	Caithness	25	1 (4.0)	0	2.0	-
	W Suth	42	5 (11.9)	3 (7.1)	1.0	1.9 (0.9-3.3)
	W Ross	44	4 (9.1)	3 (6.8)	1.8 (0.9-3.2)	1.0
	W Ness	61	5 (8.2)	7 (11.5)	1.4 (0.9-3.2)	1.4 (0.9-2.2)
	E Suth	24	0	2 (8.3)	-	1.0
	E Ross	36	2 (5.6)	0	1.0	-
	E Ness	70	17 (24.3)	18 (25.7)	1.9 (1.3-2.8)	2.3 (1.7-3.0)

1. X^2 tests for differences of proportions. Otter, 8df: 1912-39, X^2=27.51, **P<0.001**; 1940-70, X^2=63.55, **P<0.0001**. Wild Cat, 6df: 1912-39, X^2=25.86, **P<0.001**; 1940-70, X^2=8.54, P=0.21, NS. Fox, 7df: 1912-39, X^2=32.18, **P<0.0001**; 1940-70, X^2=16.12, **P<0.05**. Pine Marten, 6df: 1912-39, X^2=36.02, **P<0.0001**; 1940-70, X^2=19.53, **P<0.01**. Badger, 6df: 1912-39, X^2=20.57, **P<0.01**; 1940-70, X^2=25.30, **P<0.001**.
2. Data normalised by log(x+1) transformation; mean and 95% CI derived by back-transformation.
3. Single-factor ANOVA for differences in mean number of animals submitted per positive square between vice-counties, performed on log(x+1) transformed data. Otter: 1912-39, $F_{8,171}$=2.756, **P<0.01**; 1940-70, $F_{8,106}$=0.729, P=0.67, NS. Wild Cat: 1912-39, $F_{6,119}$=3.211, **P<0.01**; 1940-70, $F_{6,64}$=1.806, P=0.11, NS. Fox: 1912-39, $F_{7,161}$=1.902, P=0.07, NS, 1940-70, $F_{7,89}$=2.260, **P<0.05**. Pine Marten: 1912-39, $F_{5,33}$=2.022, P=0.10, NS; 1940-70, $F_{6,29}$=0.222, P=0.97, NS. Badger: 1912-39, $F_{5,28}$=0.776, P=0.58, NS; 1940-70, $F_{4,28}$=2.01, P=0.12, NS, excluding the record from Skye.

Changes in the Numbers of Carnivores Submitted

Otter: The total number of Otters submitted per year increased significantly between 1912 and 1931 (r_S=0.857, n=20, P<0.01), and decreased from 1931 to 1970 (r_S = -0.890, n=40, P<0.01)(Figure 1). This general trend was found for all vice-counties and areas of differing land use.

Wild Cat: Similarly, the numbers of Wild Cats submitted per year increased between 1912 and 1931 and decreased between 1931 and 1970 (r_S=0.897, n=20, P<0.01; r_S= -0.838, n=40, P<0.01 respectively). The years in which the maximum numbers were submitted from each vice-county showed greater variation than found for Otter. Numbers from West and East Ness and Ross peaked between 1928 and 1931; numbers from East and West Sutherland peaked in 1939, and from Caithness in 1941, suggesting increases in these vice-counties.

Fox: The numbers of Foxes submitted per year between 1919 and 1929 were significantly higher than numbers submitted between 1912 and 1918 (Mann-Whitney U-test, U=3, P<0.05). Overall, numbers peaked in 1919-20; other than this peak, there was a steady increase in numbers submitted until 1928-29. Numbers from East Ness, East Ross, West Ness, West Ross and Skye peaked in 1919-20, whereas numbers from Caithness, West and East Sutherland peaked in 1928-29; numbers from East Ness showed peaks at both times. Peaks in numbers in 1919-20 and 1927-29 were pronounced in areas of mixed and upland land use; numbers from areas of lowland land use peaked in 1920 and declined thereafter. Numbers submitted in the 1930s were significantly lower than they had been during 1919-29 (Mann-Whitney U-test, U=3, P<0.05), having shown a large decline from 1930; this general trend was found in all vice counties and land use types. Numbers fluctuated around the time of the Second World War (see below); numbers showed a sharp drop in 1951 and never recovered: numbers submitted during 1951-70 were significantly lower than those submitted during 1940-50 (Mann-Whitney U-test, U=0, P<0.05)(Table 4). This pattern was consistent throughout the area and across all land use types.

Pine Marten: The number of Pine Martens submitted per year increased significantly between 1912 and 1935 (r_S=0.526, n=24, P<0.01). Numbers from West Sutherland showed the most pronounced peak, which was in 1935; numbers from West Ross peaked in the 1920s. Numbers from eastern vice-counties peaked later: East Ross in 1937, East Sutherland in 1939-41 and East Ness in 1953. The number submitted per year decreased significantly between 1935 and 1970 (r_S= -0.738, n=36, P<0.01).

Table 6. Numbers of carnivores submitted from areas of differing land use in relation to 10km squares of the National Grid

Species	Land use	Total no. of squares[1]	No. (%) of 10km squares from which submitted[2]		Mean (& 95% CI) no. submitted per positive square[3,4]	
			1912-39	1940-70	1912-39	1940-70
Otter	lowland	15	7 (46.7)	7 (46.7)	5.7 (2.1-13.2)	4.0 (1.8-7.8)
	mixed	239	108 (41.8)	76 (28.9)	3.8 (3.2-4.6)	2.8 (2.2-3.4)
	upland	173	65 (31.8)	32 (15.0)	2.7 (2.1-3.3)	2.0 (1.4-2.8)
Wild Cat	lowland	15	7 (46.7)	5 (33.3)	4.7 (1.6-11.2)	3.6 (1.3-8.4)
	mixed	114	58 (50.9)	35 (30.7)	3.4 (2.6-4.4)	2.5 (1.8-3.4)
	upland	173	61 (35.3)	31 (17.9)	4.2 (3.1-5.7)	2.3 (1.7-3.1)
Fox	lowland	15	6 (40.0)	6 (40.0)	4.6 (1.5-11.6)	2.5 (0.7-6.1)
	mixed	162	80 (49.4)	58 (35.8)	4.1 (3.3-5.0)	2.2 (1.9-2.5)
	upland	173	83 (48.0)	33 (19.1)	4.2 (3.3-5.3)	1.8 (1.4-2.2)
Pine Marten	lowland	15	2 (13.3)	1 (6.7)	1.0	2.0
	mixed	114	17 (14.9)	16 (14.0)	2.7 (1.7-4.1)	2.1 (1.4-3.1)
	upland	173	20 (11.6)	19 (11.0)	1.8 (1.3-2.6)	1.5 (1.1-1.9)
Badger	lowland	15	1 (6.7)	4 (26.7)	2.0	4.1 (2.3-7.0)
	mixed	114	13 (11.4)	15 (13.2)	1.7 (1.0-2.7)	1.8 (1.3-2.4)
	upland	173	19 (11.0)	15 (8.7)	1.6 (1.2-2.0)	1.3 (1.1-1.6)

1. The number of squares varies between species as they were not found throughout the area; Skye and the Outer Hebrides were excluded for Pine Marten, Wild Cat and Badger, and the Outer Hebrides was excluded for Fox.
2. X^2 tests for differences of proportions, 2df. Otter: 1912-39, X^2=4.81, P=0.09, NS; 1940-70, X^2=47.40, **P<0.0001**. Wild Cat: 1912-39, X^2=7.05, **P<0.05**; 1940-70, X^2=7.09, **P<0.05**. Fox: 1912-39, X^2 =0.50, P=0.78, NS; 1940-70, X^2=69.64, **P<0.0001**. Pine Marten: 1912-39, X^2=0.69, P=0.71, NS; X^2=1.22, P=0.54, NS. Badger: 1912-39, X^2=0.31, P=0.86, NS; X^2=5.30, P=0.07, NS.
3. Data normalised by log(x+1) transformation; mean and 95% CI derived by back-transformation.
4. Single-factor ANOVA for differences in the number submitted per positive square from areas of differing land use, performed on log(x+1) transformed data. Otter: 1912-39, $F_{2,177}$=3.961, **P<0.05**; 1940-70, $F_{2,112}$=2.023, P=0.14, NS. Wild Cat: 1912-39, $F_{2,123}$=0.651, P=0.52, NS; 1940-70, $F_{2,68}$=0.551, P=0.58, NS. Fox: 1912-39, $F_{2,166}$=0.04, P=0.95, NS; 1940-70, $F_{2,94}$=1.54, P=0.21, NS. Pine Marten: 1912-39, $F_{2,36}$=1.616, P=0.21, NS; 1940-70, $F_{2,33}$=1.121, P=0.33, NS. Badger: 1912-39, $F_{2,31}$=0.084, P=0.92, NS; 1940-70, $F_{2,31}$=9.224, **P<0.001**.

Badger: The numbers of Badgers submitted per year were generally similar from 1912 to 1970, excepting fluctuations around the time of the World Wars (see below) and a noticeable peak in 1928, mainly due to an increase in the numbers from East Ness.

General: The general pattern of submission of Otter, Wild Cat and Fox, with increases in the 1920s and early 1930s and declines thereafter, was mainly due to changes in the numbers submitted from areas of mixed and upland land use (Table 4). Numbers of Otters submitted during 1912-19 and 1920-29 increased three-fold, seven-fold and six-fold in areas of lowland, mixed and upland land use respectively. This was matched by larger declines in numbers submitted from areas of mixed and upland land use between 1940 and 1970 (Table 4), so that the numbers submitted from areas of each land use type between 1912-19 and 1960-70 were generally similar. Declines in numbers of Wild Cats and Foxes were even more pronounced from areas of mixed and upland land use, so that the decline in numbers of Foxes from upland areas was ten times that in lowland areas when the periods 1912-19 and 1960-70 were compared. The proportion of Badgers which came from areas of differing land use showed significant variation when the periods 1912-39 and 1940-70 were compared (χ^2 =15.04, 2 df, P<0.001). This was because the proportion from upland areas dropped whilst that from lowland areas increased. Badgers were submitted from lowland areas in 1928, 1939 and 1941, and more regularly from 1947 onwards.

Changes in the Numbers of Skins Offered for Sale

More than 90% of Fox and Wild Cat skins, and 70% of Badger skins, which were offered for sale to Macpherson's were offered before 1930. More Otter (63%) and Pine Marten (59%) skins were offered after 1930. It is probable that Macpherson's did not purchase Fox, Wild Cat and Badger skins after 1930: one Wild Cat skin offered in 1947 was 'not required', as was one Fox skin offered in 1945. However, the stuffing books would have still recorded if any skins were brought in, even if they were not purchased. Fox skins may have been submitted to the Highland Agricultural Executive Committee bounty scheme from 1948 onwards. All Otter and Pine Marten skins offered for sale were purchased, so that demand must have existed for the skins of these species (see also below).

Effects of World Wars

Numbers of all species submitted, with the exception of Badgers, were reduced during the period of the First World War (1914-18) (Figure 1). Similarly, depressed numbers of Otters, Wild Cats and Pine Martens were submitted during

1940-44. There were often peaks in numbers immediately after the war periods. Peaks in numbers were found in areas of all land use types, but were especially noticeable in areas of mixed and upland land use. Numbers of Otters and Wild Cats submitted did not display peaks after the World Wars. The number of Badgers submitted showed the reverse situation, and numbers were significantly higher during 1914-16 than in other years between 1912 and 1919 (Mann-Whitney U test, $U=0$, $P<0.05$); the peak in numbers from East Ness was especially pronounced. Higher numbers of Badgers were also submitted during 1940-43 than between 1935 and 1939. There was a very pronounced peak in numbers in 1946, the maximum in any one year, with high numbers coming from East Ness and West Sutherland. There were peaks in the numbers of skins offered for sale to Macpherson's of all species except Badger in 1918-20. Similarly, there was a peak in the number of Otter skins offered in 1946-47, and a peak in the number of Pine Marten skins offered in 1947-48. Items of clothing, namely furs and stoles, were known to have required one clothing ration coupon during 1945-48; other items, including gloves, did not.

Numbers of Carnivores Submitted from Sutherland Estates in Relation to Land Use

Sutherland estates were described as grouse moors (18), deer forests (11) and mixed estates (16) in the early 20th century (Dunrobin office, 1905; Table 8). Deer forests were larger than grouse moors, and mixed estates were intermediate in size. Most deer forests were in West Sutherland, whilst most grouse moors were in East Sutherland. Gamekeepers were found at higher density on grouse moors. Numbers of Foxes, Wild Cats and Otters submitted from these were studied. Records could be reliably allocated to most estates (17, 10 and 15 estates respectively); records from the remaining estates were not included in this analysis. Foxes were submitted from a higher proportion of grouse moors than deer forests; Wild Cats were not submitted from any deer forests, whereas Otters were submitted fairly uniformly between 1912 and 1939, but not from any grouse moors between 1940 and 1970 (Table 9). Numbers submitted of each species did not show large variation between different types of estate. There was considerable variation, however, when estate size was allowed for; these variations were generally correlated with the proportions of estates from which animals were submitted, suggesting that they represent real differences. Significantly higher numbers of Foxes were submitted from grouse moors when compared to deer forests between 1912 and 1939 (2 sample t-test, $t=-1.995$, 20df, $P<0.05$), but there was much less variation was after the Second World War. Numbers of Wild Cats submitted showed large variation, due to high numbers coming from individual estates. Otters were submitted in lowest numbers from grouse moors.

Table 7. Numbers of Wild Cats submitted from outside the Highlands

Vice county	Numbers of Wild Cats submitted[1]						
	1912-19	1920-29	1930-39	1940-49	1950-59	1960-70	Total
Renfrew vc76				2			2 (1)
Stirling vc86			1		1	1	3 (2)
West Perth vc87			1	2			3 (2)
Mid Perth vc88		15 (8)	7 (6)	4 (2)		3 (3)	29 (16)
East Perth vc89			1				1 (2)
Forfar vc90				1			1
Kincardine vc91						1	1
S Aberdeen vc92				2	5 (3)	9 (6)	16 (9)
N Aberdeen vc93					1		1
Banff vc94		2 (2)				1	3 (2)
Elgin vc95[3]				10 (3)		1	11 (4)
Main Argyll vc98[3]		1	7 (4)	13 (7)	5 (5)		26 (14)
Clyde Isles vc100		1					1
Kintyre vc101				6 (2)			6 (2)
S Ebudes vc102			1				1
England			1		1		2
Total		**19**	**19**	**40**	**13**	**15**	**104**
Highland total[2]	99	356	415	159	45	50	1124
Grand total	**99**	**375**	**434**	**199**	**58**	**65**	**1228**
% from outside Highlands	0	5.3%	12.4%	25.2%	26.7%	30.0%	8.5%

1. Where animals were submitted from more than one locality, the number of localities is given in brackets
2. Figures from Table 3
3. Excluding sections included in East and West Ness respectively included in north Scotland area (see Methods)

Table 8. Characteristics of Sutherland estates in relation to land use[1]

Land use	Number of estates[2]	Mean (& SD) area (km^2)	Mean (& SD) number of gamekeepers	Mean (& SD) density of keepers (keepers/10km square)
deer forest	11 (10)	116.8 (48.2)	2.3 (1.3)	2.1 (1.2)
mixed	16 (15)	92.4 (38.5)	1.5 (0.6)	1.8 (0.8)
grouse moor	18 (17)	64.0 (33.9)	1.3 (0.5)	2.6 (1.8)

1. Figures from Dunrobin Office (1905)
2. Numbers of estates included in calculations given in brackets

Table 9. Numbers of Fox, Wild Cat and Otter submitted from Sutherland estates in relation to land use

Species	Land use	Number of estates			Number of animals per positive estate[1]			
		Total	No. (%) submitting animals		Mean (& 95% CI)		Mean (& 95% CI) per 10km square	
			1912-39	1940-70	1912-39	1940-70	1912-39	1940-70
Fox	deer forest	10	7 (70)	1 (10)	2.4 (1.2-4.3)	3.0	2.3 (1.2-4.0)	1.5
	mixed	15	9 (60)	4 (27)	2.8 (1.4-4.9)	1.2 (0.8-1.7)	3.0 (1.8-4.8)	1.1 (0.8-1.4)
	grouse moor	17	15 (88)	3 (18)	2.4 (1.7-3.3)	1.7 (1.1-2.5)	4.2 (3.1-5.6)	1.9 (0.5-4.6)
Wild Cat	deer forest	10	0	0	-	-	-	-
	mixed	15	7 (47)	4 (27)	2.4 (0.8-5.3)	6.7 (1.4-24.1)	2.6 (1.0-5.7)	8.4 (2.4-25.2)
	grouse moor	17	7 (41)	4 (24)	2.4 (1.4-3.8)	1.9 (1.2-2.9)	3.1 (1.7-5.3)	3.1 (1.2-7.0)
Otter	deer forest	10	5 (50)	2 (20)	2.9 (1.2-6.0)	1.4 (0.6-2.7)	3.1 (1.5-5.7)	1.4 (0.0-4.9)
	mixed	15	7 (47)	3 (20)	2.4 (0.9-5.2)	1.7 (0.5-4.0)	3.6 (1.2-8.5)	2.2 (0.6-5.7)
	grouse moor	17	8 (47)	0	1.8 (0.9-3.2)	-	2.5 (1.4-4.2)	-

1. Data normalised by log(x+1) transformation; mean and 95% CI derived by back-transformation

Table 10. Known uses of animal skins from north Scotland, 1945-70

Period	Species	Number of animals					
		Tanned/ Dressed	Furs	Sporrans	Gloves	Other items	Mounted
1940-47	Otter[1]	64 (24)	7		6	1	
	Wild Cat	19					
	Fox	41	40		2		2
	Pine Marten	3	3				
	Badger	7	1	1			
1948-59	Otter[1]	21 (11)		2	3		
	Wild Cat	5					
	Fox	11	11				
	Pine Marten	2	2				
	Badger	3					
1960-70	Otter[1]	41 (2)		5		3	
	Wild Cat	27		21		1	1
	Fox	10				1	
	Pine Marten	8					1
	Badger	8		7			

1. Number of which plucked given in brackets

Proportions of Animals killed on Estates which were submitted to Macpherson's

The numbers of Wild Cats submitted to Macpherson's from estates were compared with the numbers killed on estates given by Jenkins (1962). Of 53 estates in north Scotland where Wild Cats were recorded to be present, animals were submitted from twelve (22.6%), eight (15.1%) and three (5.7%) estates in the 1930s, 1940s and 1950s respectively. The mean proportions of animals killed which were submitted for preservation from each estate were 13.2%, 2.6% and 2.5% in the 1930s, 1940s and 1950s respectively, thus providing evidence of a decline in interest in preserved skins. Extrapolating these proportions to the whole of north Scotland, taking the mean number submitted per year as approximately 41.5, 15.9 and 4.5 in the 1930s, 1940s and 1950s respectively (from Table 3), would give figures of 314, 612 and 180 Wild Cats killed per year in north Scotland in these decades respectively. Although these figures are estimates, it is likely that several hundred Wild Cats were being killed per year in north Scotland.

Value of Skins

The prices paid for skins by Macpherson's were known for the period 1945 to 1949. Macpherson's paid between 20/- and 25/- for average Otter skins, paying less (15/-) for small skins, and more (35/- to 40/-) for large skins. In 2001 these prices are equivalent to approximately £25-£30 for average skins, £20 for small skins and £45-£60 for large skins. Macpherson's paid 25/- for Pine Marten skins in 1945 and 1948, and 18/6d for a small Marten in 1947; in 2001 these prices are equivalent to £30-£35 for average skins and £22 for the small skin. By way of comparison, the average agricultural workers' wages were 72-94 shillings per week, equivalent to £90-£100 in modern terms (Anon, 1981). Thus, the sale of a skin would have represented the equivalent of between one and two days work, a fairly considerable sum. One lighthouse keeper who submitted five Otters in 1945-46 was paid £5.4s.6d, equivalent to £145, or over one week's wages at that time; this was apparently the most that one person was paid by Macpherson's between 1945 and 1949.

Uses of Skins

The uses of animals were known between 1940 and 1970 (Table 10). Most carnivores were to be preserved by Macpherson's as skins, and very few were to be mounted. Many skins were to be made into articles of clothing; the owners may have made some into garments, after Macpherson's had preserved them. Fox and Pine Marten were frequently made into fur collars and stoles; Otter was also made

Table 11. Records of Polecat, Ferret and Mink submitted from Scotland to Macpherson's

Taxidermist's identification	Year of submission	Number of animals	Address of submitter	Vice-county
'Polecat'	1916	1	Rhidorroch	W Ross
	1932	5	Rossal, Mull	
	1941	1	Brahan	E Ross
	1944	2	Tobermory, Mull	
	1945	2	Benhiant, Tobermory, Mull	
	1959	1	Braemore	W Ross
'Polecat-Ferret'	1925	1	Kingussie	E Ness
	1925	3	Stock	-
	1942	1	Inverness	E Ness
	1944	1	Inverness	E Ness
'Ferret'	1920	1	Stock	-
	1930	1	Sandside, Reay	Caithness
'White Ferret'	1945	4	Tobermory, Mull	
Mink	1959	1	Dalreavoch	East Sutherland
	1960	2	Cruden bay	Aberdeenshire
	1961	2	Glenlivet, Tomintoul	Moray
	1964	2	Kinellar, Clinterty	Aberdeenshire
	1964	1	Ralia, Kingussie	East Ness
	1966	1	Muir of Ord	East Ross
	1968	1	Fasnacloich, Appin	Argyll

into furs, although to a lesser extent, and also into other articles of clothing, especially gloves. Wild Cat and Badger were mainly made into sporrans, as were many Otters. Pine Martens and Polecats are also known to have been made into sporrans earlier in the 20th century (Author's data). There were some variations in use during 1940-70, with a higher proportion of animals being made into sporrans after 1960, and a lower proportion made into furs.

Other Carnivore Species: Polecat, Ferret and Mink

Records of Polecat, Polecat-Ferret and Ferret are of interest (Table 11). Published records of Polecat in Scotland from 1910 onwards came from Lairg (East Sutherland) in 1912 and Morvern (Argyll) in 1928 (Ritchie, 1920; Tetley, 1939), although there were unconfirmd sightings into the 1960s (I. Evans, pers. comm.). The Rhidorroch (West Ross) 'Polecat' record for 1916 would therefore represent one of the last records; this animal was offered for sale to Macpherson's. It is difficult to determine whether or not some of these animals were indeed Polecats, Ferrets or hybrids. Two later records of 'Polecats', from East and West Ross, more likely referred to Polecat-Ferrets or Ferrets, although the Braemore record would be close to some of the last places where Polecats occurred in Scotland in the 20th century. Most records of 'Ferrets' and 'Polecat-Ferrets' were from the eastern counties, and from Mull, where a feral population has been established since at least the 1920s (Pocock, 1932; Yeaman, 1932; Tetley, 1945).

Mink were submitted from several east coast localities as well as one locality in Argyll between 1959 and 1970. All except those from Ralia (East Ness) and Glen Livet (Moray) were submitted from localities close to known Mink farms, which mainly became established in Scotland from the 1940s onwards (Cuthbert, 1973); these two records may suggest the existence of unknown, probably small, Mink farms in these areas.

Discussion

Factors Affecting the Numbers of Animals Submitted

The declining proportions of Wild Cats which were submitted provide evidence of a general decline in interest in skins. However, changes in the numbers of animals submitted to Macpherson's do not simply reflect changes in the fashionability of furs or a change in the market, since changes in the numbers submitted varied significantly between vice-counties and areas of differing land use. Changes in fashion would be expected to have the same effect in all areas. The numbers of animals submitted to Macpherson's were determined by a number of

factors. Foremost amongst these were the desirability and availability of skins. Availability would have been determined by carnivore population sizes, persecution pressure, and persecution methods, as already mentioned. Deer, carnivores, birds of prey, hares and rabbits are the groups which figure most heavily in the stuffing books; these groups were of the greatest interest for trophies, mounts, skins, furs and taxidermy. Carnivores had a particularly ambiguous status, being generally considered as 'vermin' when alive, and yet valuable for furs or suitable subjects for taxidermy when dead, as they still are to some extent. Ritchie (1920) listed the following species, in descending order of the desirability of their fur, as Pine Marten (and Polecat), Fox, Otter and Badger. In Scotland, Badgers and Otters were also in demand to be made into sporrans, and this was responsible for intense persecution of these species in the late 19th century (Dixon, 1886; Forsyth, 1900). All species were therefore of some use once dead; rare animals would also have been more likely to be preserved for their value as curiosities (Morris, 1993; McGhie, 1999). The interest in mounted animals was very small compared to the interest in furs, to judge from the numbers of animals submitted for these purposes. Similarly, the numbers of Wild Cats submitted represented a fairly small proportion of the numbers which were known to have been killed, so that the killing of Wild Cats for their skins, even specifically for that purpose, would have represented a minor cause of mortality. This may not have been true for Otter and Pine Marten, since these had a skin which could be sold, and certainly the numbers of Pine Martens submitted were surprisingly high.

Methods and Specificity of Persecution

The main persecution methods included trapping, poisoning and shooting. Trapping was mainly with gin traps and snares (Speedy, 1924; Bateman, 1971). Trapping of Rabbits *Oryctolagus cuniculus* was also a major industry before the advent of myxomatosis in the 1950s, and many carnivores were known or thought to have succumbed to traps set for Rabbits as they searched for food or for shelter in burrows (e.g. Harvie-Brown and Buckley, 1895; Jenkins, 1962). In the uplands, attention was concentrated at cairns, which were deliberately built to attract animals; these cairns were attractive to all species of carnivore (e.g. Harvie-Brown and Buckley, 1895). Poison baits often consisted of poison-laced eggs or carcasses (e.g. Speedy, 1924), which would have been attractive to a wide variety of animals. A major part of persecution, trapping and poisoning, was therefore fairly non-selective, and many species other than the target species were caught. Some species would have been more vulnerable to trapping than others. Pine Martens were considered to be easily trapped (Harvie-Brown and Buckley, 1904); most animals caught were males, probably as a result of the Marten's territorial system (see Balharry, 1993). Otters were not considered to be easily trapped because they

had wide-ranging habits and were not attracted to poison baits (Jefferies, 1989); nor were Badgers (Millais, 1904-06). Even where certain species were conserved as far as possible, they were frequently caught in traps set for other species (Harvie-Brown and Buckley, 1895; Mackenzie, 1921 and 1924; Lockie, 1964) The actual numbers submitted of each different species are not directly comparable with each other because of these differing factors, since the numbers submitted of each species probably represent different proportions of the species' populations and of the numbers killed. For example, more Pine Martens were submitted than Badgers, even though Pine Martens were almost certainly rarer; this could be due to the greater desirability and value of Marten skins (Macpherson's would also purchase Marten skins) or to the greater ease with which Pine Martens could be trapped.

Distribution of Carnivores

Velander (1983) cautioned that the use of records of trapped animals may reflect trapping pressure rather than true distribution. Persecution pressure may in part account for the relative distribution of the numbers of records in the present study. However, it is also true that animals were submitted from a large proportion of the area, and persecution would have been likely to extend to all species in varying degrees, at least due to a lack of specificity of methods. As a consequence of this, the absence of records of species being submitted from large areas are likely to mean that those species were either not present or were at the least very rare in those areas. It is therefore likely that the distribution of records gives a good indication of the distribution of the species studied.

The distribution of records of Fox and Otter corroborated published distributions for these species in the early 20th century (Hewson and Kolb, 1973; Jefferies, 1989), but this may simply be because these species were widely distributed. Badgers were found in more widely scattered areas than mapped by Darling (1947); the record from Raasay (Skye) in 1950 probably relates to an animal from elsewhere, since the Badger is not regarded as native there (e.g. Cresswell *et al.*, 1990). High numbers were submitted from East Ness, particularly Strathspey, where strong populations had been reported (Marshall, 1935; in Neal, 1948). Relatively high numbers of Badgers submitted from lowland areas after the Second World War provide evidence of relatively large increases in numbers there, perhaps colonization.

The distribution of Wild Cat corroborates that reported by Balharry and Daniels (1999) for the early 20th century and by Taylor (1946), in that the Wild Cat was fairly widely distributed throughout much of the Highlands, especially throughout

the straths and uplands of eastern areas. Langley and Yalden (1977), based on a literature review, postulated that Wild Cats became confined to a relict area north of the Great Glen by about 1915 as a result of persecution, with the centre of distribution being in central Ross-shire. The distribution of records from the stuffing books contradicts this; distribution would appear to have been wider, even during 1912-19, covering Ross and Ness in north Scotland, and possibly also Perthshire, and that Wild Cats were actually very rare in Sutherland. Taylor (1946) commented that naturalists had probably considered the species to be rarer than was actually the case. Evidence from the stuffing books suggests that numbers consolidated themselves throughout Ross and Ness and that Wild Cats spread into adjacent areas, probably from the First World War onwards. The proportions of animals submitted from outside north Scotland suggest that this increase accelerated with the Second World War. Jenkins had considered Wild Cats to be uncommon in Ross, but he had very few questionnaire returns for the area. Wild Cats had been submitted in large numbers from Ross before the Second World War, although only small numbers were submitted after the 1940s. It is not known whether this represents a real decrease, although this is unlikely as persecution was reduced, and large areas of suitable but less 'keepered habitat would have been created in new forestry plantations.

Findings for Pine Marten generally corroborate those of Lockie (1964), Langley and Yalden (1977) and Velander (1983); Darling (1947) recorded some of the animals submitted to Macpherson's. The stuffing books also point to the existence of a relict population in the Kyle of Sutherland and its tributary glens, and possibly Easter Ross, or at least that these areas were colonised earlier than previously thought. These areas are reasonably close to the Assynt district and are linked to it by a number of glens, notably via the corridor of Loch Shin and other valleys. Pine Martens were noticed to have increased from the 1920s in West Sutherland and West Ross (Lockie, 1964). Persecution was obviously still intense in the north-west Highlands, to judge from the numbers of Pine Martens submitted to Macpherson's in the 1930s. Lockie drew attention to how many Pine Martens continued to be trapped inadvertently in the north-west, even where keepers and owners were willing to preserve them as a result of Fergusson's campaign (see Fergusson, 1939). Thus, there may not have been sufficient animals to account for the spread of animals into other areas. It is suggested that increases in East Ness and Ross, Moray and Deeside also represent more local increases rather than the product of emigrations from the north-west

A large number of people had vested interests in carnivores, in that employers often paid vermin money and skins could be sold, both for furriery and taxidermy. Foxes in particular formed a source of revenue for many people in that organised

hunting with dogs was carried out, even in Scotland. Cubs were also sold to England for fox-hunting (Harvie-Brown and Buckley, 1904; Millais, 1904-06), adult Foxes were also sometimes trapped with special gin traps with rubber jaws to avoid breaking the animals' legs, so that the animals could be sold for fox-hunting (Speedy, 1924). Foxes thus received some protection, since it would be "a mistake to kill the goose that lays the golden eggs" (Harvie-Brown and Buckley, 1895) Information provided to early writers, most notably Harvie-Brown, generally came from gamekeepers and other land users. This information cannot be regarded without qualification, as these people were generally being paid to keep the numbers of carnivores down. Those with vested interests may have provided information which suited their own requirements (see Mason and Macdonald, 1986), so that gamekeepers may therefore have exaggerated claims of rarity, to avoid remonstration from employers and possibly also to ensure the continuation of the bonus system. Also, information would pertain to areas which were 'keepered, and it is not generally clear if carnivores were trapped over whole estates or only on certain beats. It is also unlikely that the whole countryside could have been 'keepered, given the remoteness of many upland areas, even at the height of sport shooting. Similarly, it is difficult to see how estimates of abundance were derived, especially in the absence of trapping, since some species, most notably the Wild Cat, are very secretive. Increases of Badger and Wild Cat in the 1920s were considered to have been too large to be possible from the remnant populations which were supposed to have existed before the First World War (see Taylor, 1946; Cresswell *et al.*, 1990). Thus, these two species were both described in terms of greater rarity than was almost certainly the case, and this may well also be true for Pine Marten (see above). Langley and Yalden (1977) had considered carnivores' ranges to have contracted in Britain towards the north-west since there were fewer gamekeepers there. This general view is accepted, but the details are not, since variations in persecution were not so clinal in nature. Vermin money was paid on Sutherland estates from a comparatively early date and Harvie-Brown and Buckley (1887, see under 'Kestrel') considered vermin to be more heavily persecuted in Caithness than in any other county in Scotland. As already stated, some species were probably more widespread than would appear to have been the case from contemporary literature, on which Langley and Yalden (1977) based their review.

Changes in Numbers of Carnivores Submitted and Suggested Causes

The most notable changes in numbers of carnivores submitted were increases until the late 1920s and early 1930s and declines thereafter; the two World Wars saw depressed numbers submitted of most species, and there were often temporary increases in numbers submitted directly after the war periods. This pattern does not

correspond with the supposed population sizes of the species under study, since these are mainly thought to have shown general long term increases through the 20th century (e.g. Langley and Yalden, 1977; Hudson, 1992; Tapper, 1992). It does coincide with the bag sizes of a wide variety of game species, however, reflecting human predation pressure, and also levels of persecution as measured by changes in the numbers of gamekeepers. Numbers of birds of prey submitted to Macpherson's followed the same pattern (McGhie, 1999).

The number of gamekeepers in north Scotland fell from approximately 12,000 in 1911 to 9,000 in 1921 and 1931; it declined further, so that there were only 500 gamekeepers in 1951 and even fewer in 1961 (Hudson, 1992). These declines were largely attributable to social changes, which occurred after each of the World Wars. Depressed numbers of carnivores which were submitted during the periods of the World Wars may therefore be attributable to declines in gamekeeping as gamekeepers were called up for service. Cartridges were known to have been rationed, at least during the Second World War (Highland Squirrel Club papers, Highland Regional Council Archive, HCA/D522). Predators increased in numbers during the War periods due to the decrease in persecution. Some are known to have had increased breeding success (Leslie, 1920 and 1924; Speedy, 1924; Newton, 1972), although some increases may have been exaggerated (see above). Many animals were killed on the resumption of persecution, bringing populations back to a lower level (Jenkins, 1962); this may be responsible for the temporary peaks in numbers of many species submitted immediately after the Wars. Vermin Clubs were set up in Argyll (1921), Ross (1921) and Perthshire (1924) to try to better organise persecution (Leslie, 1920 and 1924). That in Argyllshire, and possibly elsewhere, was established along the same lines as the Highland Squirrel Club, in that persecution was to extend over a large contiguous area and therefore to discourage some estate owners from offering a safe haven to 'vermin' (Leslie, 1920 and 1924; Collier and McGhie, in press) Declines in gamekeeping have been linked with increases in carnivores and birds of prey (e.g. Ritchie, 1920: Lockie, 1964; Newton, 1972; Hudson, 1992; Tapper, 1992).

The numbers killed of a wide variety of upland and farmland species increased through the 1920s in north Scotland. These include Mountain Hare *Lepus timidus*, Brown Hare *Lepus capensis*, Grey Partridge *Perdix perdix*, Red Squirrel *Sciurus vulgaris* and Red Grouse *Lagopus lagopus* (Hewson, 1953 and 1954; Hudson. 1992; Tapper, 1992; Collier and McGhie, in press; Author's data). The number of gamekeepers certainly did not change significantly between 1921 and 1931, although it is difficult to imagine any factor common to all of these species Examination of the gamebooks of one East Ross estate showed that hunting pressure, in terms of the number of days spent shooting and shooting party sizes in

moorland and woodland, was high in the 1920s and declined thereafter; hunting pressure on farmland did not decline so dramatically. However, some game species still showed increases in the 1920s and declines in the 1930s when variations in hunting pressure were allowed for (Author's data). Similarly, Hewson (1954) did not believe variation in persecution to be responsible for the large increases in the late 1920s when considering Red Squirrel and Mountain Hare. Increases in the numbers of carnivores submitted to Macpherson's in the 1920s may therefore represent a true reflection of the population increases which were noted for some species (Leslie, 1920 and 1924; Jenkins, 1962; Lockie, 1964). An increase in hunting effort in the 1920s may have had some additional effect. The numbers of carnivores were thought to be increasing in many areas in the 1930s (e.g. Jenkins, 1962; Lockie, 1964), so that it is unlikely that the declining number of carnivores submitted reflect carnivore population sizes. Another possible cause is that the number of gamekeepers fell during the Great Depression in the 1930s, and that some of the decrease in the number of gamekeepers between 1931 and 1951 occurred before the outbreak of the Second World War rather than after it. Late peaks in the numbers of Wild Cats and Pine Martens from some vice-counties are evidence of the spread of these species into some areas. Numbers of carnivores declined further after the Second World War; this may in part be attributed to declines in gamekeeping, but the declining proportion of Wild Cats which were submitted from estates provides evidence of a decline in interest in skins and taxidermy, at least from wild animals.

Some writers commented that carnivores were preserved in deer forests in order to keep down the numbers of Grouse and Mountain Hares, since these could interfere with stalking and competed with Red Deer *Cervus elaphus* for food (Harvie-Brown and Buckley, 1895 and 1904; Millais, 1904-06). They were, however, killed intensively on grouse moors and sheep walks because of perceived depredations. Thus the conversion of grouse moor and sheep walk to deer forests in the late 19th century may have led to decreases in persecution. Harvie-Brown and Buckley (1895) noted that the food supply, presumably in the form of Mountain Hares and Red Grouse, was reduced when grouse moor was converted to deer forest. These two forms of land use may thus have presented carnivores with different costs and benefits, with a more favourable persecution situation on deer forests but less favourable food supply when compared to grouse moor, although this description of food supply may have been over-simplistic. For example, many animals were submitted to Macpherson's from areas east of the Great Glen. This area coincided with the main distribution of grouse moors, where there was a large food supply in the form of preserved Red Grouse but where gamekeepers were found at a higher density than elsewhere (Hudson, 1992; Tapper, 1992). Harvie-Brown and Buckley (1895) noted that most records of Wild

Cats came from west of the Great Glen; the reverse pattern was found in the stuffing books, with greater numbers being submitted from east of the glen. One explanation for this difference is that persecution was still more intense east of the glen, but not intense enough to control the population, as found by Jenkins, Watson and Miller (1964). Lockie (1964) had thought that the Great Glen formed a geographical barrier to the spread of the Pine Marten, as it was more widely distributed to the west than the east of Loch Ness. It is perhaps more likely that spread was limited by the more intense persecution in the grouse moor district to the east of the Great Glen, since Pine Martens are highly mobile and in any case the Great Glen is crossed by a number of man-made structures.

Declines in gamekeeping were not constant throughout the area, and Hudson (1992) demonstrated that gamekeeping declined most in upland areas. Further declines were due to the conversion of grouse shooting, where gamekeeping is most intensive and keepers are at high density, to other forms of land use (Hudson, 1992). This explains the relatively greater decreases in numbers of Otters, Wild Cats and Foxes submitted from upland areas to Macpherson's. Similarly, the proportion of animals submitted from West Sutherland, which contains a relatively large amount of land under upland land use, decreased more than from other vice-counties. The proportion of Badgers from lowland areas increased from 0-45% from 1912 to 1970, with much of the change occurring after the Second World War, although this possibly also reflects increases in the lowlands.

In conclusion, the stuffing books provide a major source of information, covering a time for which there are few published figures available. They provide novel information on the distribution of carnivores and on regional variations in the numbers of animals killed. They demonstrate that taxidermy was of minor importance in terms of killing animals, when compared to the numbers killed as a regular part of persecution, and point to the numbers which were being killed. Similarly, the amounts of money which could be made by selling the skins of some species were relatively small for most people, although possibly important for a small number of individuals.

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NOTES ON THE GRASSHOPPERS OF RENFREWSHIRE

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Introduction

The order Orthoptera consists of the grasshoppers, crickets and allied insects, of which the grasshoppers are undoubtedly the most attractive; the allied insects, consisting of the cockroaches and earwigs, are probably considered to be somewhat less attractive by most people. This short paper deals with the grasshoppers (family Acrididae) which have been recorded for the county of Renfrewshire. Grasshoppers are certainly among the more conspicuous and easily recognised insects, but despite this, relatively little interest seems to have been taken in them by Renfrewshire field-naturalists in the past.

No previous account of the grasshoppers has appeared in the past 150 years of the Renfrewshire Natural History Society's *Transactions* or other publications. We find this rather surprising, since the late A.M. Stewart F.R.E.S., a distinguished entomologist of his day, and a Past-President and for so long a stalwart member of the Renfrewshire Society, made a significant contribution to our knowledge of local distribution in W.J. Lucas's *Monograph of the British Orthoptera* (1920), and could easily have provided a separate accurate account of Renfrewshire's grasshoppers, had he so wished. We find this omission to be something of a mystery.

The time is therefore clearly overdue for filling this gap in our county's records, particularly since the latest national distribution Atlas (Haes and Harding, 1997) gives very few records for Renfrewshire. It is therefore hoped that the following simple notes on distribution, based on some fifty years of collected observations, will be of interest to other county naturalists.

Identification

Although 'grasshoppers' are usually easily recognised as such by almost everyone, identification of individual species can be quite another matter. The identification guides we originally used were by Burr (1936) and later by Ragge (1965), but recently we have used Marshall and Haes (1988), a work which

updates and supplements Ragge's book, "long established as the orthopterist's Bible".

Collecting of grasshoppers is usually most easily carried out by the use of a standard butterfly net. Thereafter, the identification method we have usually used for any insect not immediately recognisable is as described in our paper on the bumble-bees of Renfrewshire (Gibson and Hillan, 2001), i e. to catch and imprison the insect for a short time in a clear plastic cup with a lid. This makes close and detailed examination easily possible, and identification, when immediately compared to a suitable key, usually reliable. It also avoids any unnecessary harm to the insect.

Life-cycle

Grasshoppers have a simple one-year life-cycle. The adult insects are active during the summer months, when they mate, lay eggs, and then die in the autumn, the eggs then hatch in the spring. Adult grasshoppers have a short life, and in our experience are really active in Renfrewshire only for the four months from early June to September, although in particularly warm summers some may still be seen until mid-October or even later.

Attraction

Most naturalists who have started to study the Orthoptera soon become quite enthusiastic, since these small creatures, particularly the grasshoppers, can be very attractive, and in this respect it is worth quoting two excerpts from the Preface to Marshall and Haes' superb 1988 volume:

> The hot sun of late July beats down on a dry grassy bank by a path. From this turf comes a chorus of brief, crisp, rasping chirps of field grasshoppers. Many of the small, slim 'stick-like' males are taking jerky little walks around the much stouter, sun-basking females, stridulating urgently, doubtless with amorous intentions, until an incautious movement by the observer sends them in all directions on their dry papery wings. Such a small but memorable incident demonstrates that Orthoptera are essentially to be enjoyed alive, for few insects fade and shrivel as unattractively after death. A cabinet of crickets or grasshoppers might have great scientific interest, but it is only in life that they really exert an undoubtely powerful aesthetic appeal.
>
> Orthoptera certainly appeal to the ear. Many species make distinctive and often attractive sounds within the range of human hearing. Most stridulate

only in fine warm weather and the sound readily becomes associated with memories of good summers.

Systematic List

The following notes are based entirely on our own observations. Originally, any information on local grasshoppers was collected fairly casually in the course of our other field-work, but recently, particularly since the publication of the splendid book by Marshall and Haes (1988), we have made a determined effort to collect detailed information on Renfrewshire grasshopper distribution. Arrangement and nomenclature follow Marshall and Haes (1988).

Family Acrididae

GREEN GRASSHOPPER *Omocestus viridulus*

This is one of the most widely distributed grasshoppers in Britain, and in our experience it is also the commonest grasshopper in Renfrewshire. It is widely distributed, and we have recorded it in reasonable numbers from agricultural grassland, golf-courses - short and long rough grass, moorland, the edges of woods, but only occasionally near the coastal fringe; it is also less common around the edges of lochs and on bog-land. In actual numbers, the Green Grasshopper accounts for most of Renfrewshire's grasshopper population.

FIELD GRASSHOPPER *Chorthippus brunneus*

Much less common than the Green Grasshopper, and rather local, but does occur in small numbers, mainly in suitable areas around the coastal grassland fringe; only isolated records elsewhere.

MEADOW GRASSHOPPER *Chorthippus parallelus*

Reasonably well distributed, in small numbers, throughout suitable parts of Renfrewshire, particularly in coarse grassland, on the moors and higher hills, and also the coastal fringe. Despite its English name, not nearly so common on meadows etc as the Green Grasshopper. Somewhat surprisingly, recent investigation (Gibson, 1996) has shown that the Meadow Grasshopper is the commonest grasshopper on the neighbouring Island of Bute, where it far

outnumbers the Green Grasshopper, but in Renfrewshire the reverse is very much the case.

MOTTLED GRASSHOPPER *Myrmeleotettix maculatus*

The least common Renfrewshire grasshopper. It does occur in small numbers, mainly on shorter grassland, but in our experience the Mottled Grasshopper only seems to be really active, and therefore easily seen, in very sunny weather indeed, which may possibly account for its apparent scarcity. Has been found in some quarries with little grassland. Any additional information would be welcome.

Summary

By far the commonest grasshopper in Renfrewshire is the Green Grasshopper, which is quite common in some suitable areas and in actual numbers accounts for most of our county's grasshopper population. The Field and Meadow Grasshoppers are reasonably, if locally, distributed, but in our experience are very much less common, and the Mottled Grasshopper seems to be relatively rare. Although we have only been able to identify four grasshopper species in Renfrewshire, these are also the only four species known to occur in Scotland (Marshall and Haes, 1988), so we are fortunate that all four Scottish species have been recorded in Renfrewshire.

In this respect, it is probably also worth drawing attention to the fact that a closely allied species, the Common Ground-hopper *Tetrix undulata* (the only Scottish ground-hopper species) also occurs fairly widely throughout Renfrewshire. A short paper about this appears in the current volume of the *Scottish Naturalist* (Gibson and Hillan, 2002).

Needless to say, we shall be extremely grateful to receive any additional information about Renfrewshire grasshopper distribution, particularly about the status of *maculatus*.

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THE COMMON GROUND-HOPPER IN RENFREWSHIRE

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Introduction

In an accompanying paper in the present volume of the *Scottish Naturalist* we give a list of the Acrididae or grasshoppers which have been recorded for Renfrewshire (Gibson and Hillan, 2002). Close relatives of the grasshoppers are the Tetrigidae or ground-hoppers, one species of which, the Common Ground-hopper *Tetrix undulata*, occurs in Scotland. During the past few years we have recorded a good many specimens throughout the county, and since, according to Marshall and Haes (1988) and the later national distribution Atlas (Haes and Harding, 1997), there appear to be no previously known Renfrewshire occurrences, it is obviously desirable to place the available details on record.

Ground-hoppers are small (c. 10 mm) and relatively inconspicuous, and were it not for their hopping activity when disturbed, they could very easily be overlooked An unusual feature is also their ability to swim. The life-cycle of *T. undulata* is also rather different from grasshoppers, in that adults or nymphs may be found at any time of the year, although mid-summer understandably sees the main population. The method of catching and identification we have usually used is similar to that described in the paper on grasshoppers (Gibson and Hillan, 2002).

Species

COMMON GROUND-HOPPER *Tetrix undulata*

During the past fourteen years, since acquiring the definitive textbook by Marshall and Haes (1988) which stimulated our interest, when out looking for grasshoppers we have also taken time to hunt for any ground-hoppers, and have found *T. undulata* in many places throughout Renfrewshire, most commonly on bare ground, in woodland clearings, and on mossy areas. The statement by Marshall and Haes that the Common Ground-hopper could swim also enabled us to capture some specimens at the side of several lochs.

We are sure that any other field-naturalists who are prepared to take the time would also be able to find specimens without too much difficulty. With regard to

numbers, it is difficult to give any accurate assessment since the insects are easily overlooked and must be searched for, but it seems to us that *T. undulata* is not really uncommon in suitable places throughout Renfrewshire.

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1872-1891

The Annals of Scottish Natural History
1892-1911

The Scottish Naturalist
1912-1939, 1948-1957, 1961-1964

The Western Naturalist
1972-1982

The Scottish Naturalist
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